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ABSTRACT

This workbook is designed for classroom use by apprentices in four-year union tilesetting programs in California. The workbook is composed of five units covering all aspects of the tilesetting process. Unit 1 introduces the tilesetting trade, including history and scope of the trade, safe working practices, and trade organizations. Unit 2 describes the tiles, materials, and tools used in tilesetting, while unit 3 explains how to read blueprints and specifications. The fourth unit describes tilesetting job processes, and the fifth unit details specialized jobs such as tile floors, steam rooms, ceilings, mosaics, curved arches, swimming pools, and stairs. A list of acronyms, a glossary of terms used in the tilesetting trade, and a list of instructional materials needed by students and for the classroom is also included in the workbook. The workbook is illustrated with black-and-white drawings and full-color photos. (KC)

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Tilesetting Workbook

CALIFORNIA STATE DEPARTMENT OF EDUCATION Wilson Riles, Superintendent of Public Instruction Sacramento, 1981

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NAME ______________________________

ADDRESS ______________________________

______________________________ **PHONE** ______________

DATE ENROLLED ______________________________

INSTRUCTOR(S) ______________________________

Tilesetting Workbook

Prepared under the direction of the
CALIFORNIA STATE EDUCATIONAL ADVISORY
COMMITTEE FOR THE TILESETTING INDUSTRY
and the
BUREAU OF PUBLICATIONS,
CALIFORNIA STATE DEPARTMENT
OF EDUCATION

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California State Department of Education
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Remittance or a purchase order must accompany all orders. Purchase orders without checks are accepted only from government agencies in California. A testbook to accompany this workbook is also available from the Department's Publications Sales office.

A complete list of publications available from the Department, including apprenticeship instructional materials for some 23 other trades, can be obtained by writing or calling Publications Sales (916-445-1260).

Questions and comments pertaining to existing apprenticeship instructional materials or to the development and production of new materials for apprenticeable trades should be directed to:

Theodore R. Smith or Bob Klingensmith
Bureau of Publications
California State Department of Education
721 Capitol Mall
Sacramento, CA 95814

Foreword

For thousands of years apprenticeship has been the most effective and important method of training skilled craftspersons. Today, as they have through the ages, apprentices learn the skills of their chosen trades through productive work and under the guidance of highly skilled workers.

A system that can endure for so many years obviously offers significant advantages and rewards to those who participate in it. The opportunity to earn while learning, increased opportunity for advancement in the trade, greater earning power, and job satisfaction are all benefits derived by apprentices.

As a teaching and learning system based on cooperation between labor and management, apprenticeship must offer advantages for employers as well. Productive work and maintenance of a supply of highly skilled labor are strong incentives for management's participation in apprenticeship.

Finally, apprenticeship benefits society in general. Quality goods and products, an ongoing supply of qualified workers, productive citizens, and opportunities for ethnic minority groups and women are among the ways in which apprenticeship positively affects local communities, states, and the nation.

On-the-job training has always been the foundation of apprenticeship, but modern apprenticeship programs include another dimension—classroom instruction designed to supplement the apprentice's jobsite learning. This classroom instruction is a vital part of the training program, because the abundance of information needed by today's skilled craftspersons to make decisions and perform the work of their trades cannot be covered adequately at the workplace alone.

The job-related courses in all trades are highly specialized, and adequate training materials are not always available from commercial publishers. In such cases the Department of Education, at the request of and in cooperation with labor and management representatives, develops training materials such as this workbook and makes them available at cost. Every effort is made to ensure that these materials are clear and comprehensive and that they provide apprentices with the most up-to-date information possible on their trades.

Tilesetting is an old and honored profession. Like all apprenticeship programs, the tilesetting program demands hard work, both on the job and in the classroom. The challenges that you will face in the next three years as a tilesetting apprentice will be exacting ones. During the difficult times I encourage you to remember the advantages of apprenticeship cited above. Keep in mind that your work and study have a purpose—to help you become an artisan in a highly respected trade and a productive citizen.

Wilson Riles

Superintendent of Public Instruction

Preface

The California State Department of Education, through the Bureau of Publications, provides for the development and production of instructional materials for California apprentices under provisions of the California Labor Standards Act. Funding for these activities is provided through a self-perpetuating account established to help serve as many apprenticeable trades as possible in the state. The materials are sold at a price based on the costs to produce and distribute them, and the proceeds are returned to the special apprenticeship account for use in further development or revision of materials.

Producing or updating materials involves a joint effort by the Department of Education and employer-employee groups representing apprenticeable trades. The process begins with a request for services from recognized industry representatives, usually a state joint apprenticeship and training committee. Trade representatives and Bureau of Publications personnel review the request to determine (1) the availability of adequate training materials from commercial publishers or from other states; and (2) the economic feasibility of the proposal.

Once the need for materials has been determined, an ad hoc statewide educational advisory committee for the industry is formed. This committee, composed of equal numbers of labor and management representatives, meets with publications personnel to determine the organization of the material, its technical content, and other details.

Generally, a journey-level person is selected to prepare a manuscript. This practice helps to ensure that the content is as up to date and accurate as possible. The manuscript is prepared in accordance with the requirements set forth by the educational advisory committee and the guidelines provided by the Bureau of Publications. Bureau personnel also confer periodically with the writer to provide technical and other assistance in the writing process.

Manuscripts approved by both the educational advisory committee and the Bureau of Publications are then edited, typeset, illustrated, and proofed by publications personnel. The author and the educational advisory committee review the camera-ready copy for technical accuracy before it is delivered to the Office of State Printing in Sacramento for printing.

All apprenticeship workbooks, testbooks (if tests are not included in the workbook), final examinations, and answer keys are warehoused, sold, and distributed at cost by the Bureau of Publications.

This revised edition of *Tilesetting* was produced in the manner described above. It was planned and approved by the California State Educational Advisory Committee for the Tilesetting Industry. The chairman of this committee was George Lavenberg of Los Angeles. The other members included James Feruzzi, Los Angeles; Jack Howe, Sacramento; Erich Paarsch, Los Angeles; Spiro Papadakis, Pacifica; Edward Pitton, Sacramento; and Lewis Swinney, San Diego. Special thanks are expressed to these individuals for their invaluable contributions to the revision effort.

THEODORE R. SMITH
Editor in Chief
Bureau of Publications

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Ceramic Tile Institute
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Gladding, McBean & Co.
Goldblatt Tool Co.
International Pipe & Ceramics Corp.
Don Justice
Marshalltown
Metal Lath Assn.
The Mosaic Tile Co.
Kent Oppenheimer
Pendleton Tool Industries
Stanford University
Stanley Tools
Superior Tile Cutter
Techcon Systems, Inc.
Tile Council of America, Inc.

After years of research and painstaking work, the massive restoration project to make California's "old capitol" structurally safe for occupancy nears completion. Shown applying quarry tile on the second-floor mezzanine of the rotunda are tilesetters from the Sacramento area. The tile being laid was manufactured domestically and in Germany to duplicate the English Minton tile that was in place in the rotunda at the turn of the century. Over 100,000 pieces were cut to size for this phase of the project. When the capitol is reopened for use, this tile will be among the most viewed—and walked on—in the state.

x

Unit A
Introduction to the Trade

TOPIC 1 — HISTORY AND SCOPE OF THE TRADE

This topic is planned to provide answers to the following questions:

- **What is the history of the tilesetting trade?**
- **Why is tilesetting considered to be a basic trade in the construction industry?**
- **What are the major processes to be learned by the apprentice tilesetter?**

Tile once was so precious that only kings could afford its use. Today, tile is economical, and tilesetting is recognized as one of the basic trades in the construction industry. The story of how it has reached that position is an interesting one. Knowing something of that history can give apprentice tilesetters a pride in the trade they have selected and a realization of the range of possibilities open to them.

History of the Trade

Through the study of tiles, we can trace the conquests of the Moslems from the Middle East, along the Mediterranean shores of North Africa, and deep into Spain. We can decipher the history of ancient Egypt and determine the tastes of the Babylonians in Old Testament times. The art of tilemaking is so old that many historians believe it originated in the valley of the Tigris and Euphrates rivers, a region that today is regarded as the "cradle of civilization."

Who first had the idea of making household articles of clay and so accidentally stumbled onto the secret of tile? A primitive person seated near a fire is believed to have idly tossed a piece of wet clay into the flames and discovered the next morning that it had hardened into a material impervious to water. Thus, the first clay cooking utensil may have been invented and the process of tilefiring discovered. Thousands of years later, the Babylonians used tiles for keeping permanent records. Legend says that even Nebuchadnezzar's father-in-law wrote the amount of his tax collections on clay tiles.

Probably the most fascinating story of tiles in ancient times is that of the Step Pyramid, which the Pharaoh Zoser ordered built as his tomb in approximately 3000 B.C. Zoser chose tile because he wanted a material in his tomb that would last forever. Centuries later, when the Step Pyramid was opened by modern archaeologists, the tiles were found to be in perfect condition. Blue tiles decorated the walls of one of the mummy chambers, and three rows of tile around the doorway recorded the deeds of and the titles won by the Pharaoh. Thanks to these tiles, a part of the glorious history of Egypt has been preserved.

The tiles used in the pyramids had a unique anchoring device. Each tile was made with a lug on the back and a hole through the lug. Reeds were placed through these holes and used to fasten the tiles to walls and other surfaces (Fig. A-1).

Although the Egyptians continued to use tiles for many centuries, the Persians were the first to develop tilemaking to an art. Upon learning the secrets of applying fine lusters to the tile surfaces, the Persians perfected glazes for rich reds and yellows and used copper and cobalt for their blues.

The Arabs probably used Persian artisans to manufacture the tiles for the construction of the tomb and mosque (house of worship) of Mohammed. As the territories of the Arabs grew to include Egypt, Tunisia, Algeria, and Morocco, more mosques were built, with more domes and more walls overlaid with tilework. Because the conquered people were not skilled in the art of tilemaking, the triumphant Arabs sent

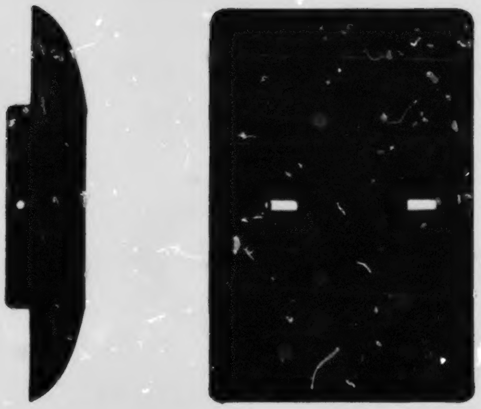


Fig. A-1. Tiles used in decorating Egyptian pyramids

back to the East for Persian tilemakers. However, once the Moslems were firmly entrenched in power, they began to establish tile factories throughout their kingdom.

As the Moors (Arabians) penetrated into Spain, they brought with them the knowledge of tilemaking and left behind them many ornate buildings with tilework more elaborate than any of that seen in the United States. The Alhambra, the fortress palace of Moorish kings at Granada, is considered to be one of the finest existing specimens of Moorish architecture.

Tile proved to be so popular in Spain that it was soon used extensively in the homes of the wealthy. Floors paved with tile not only proved pleasant to the eye, but they also provided the occupants with a cool, soothing feeling in the warm Spanish climate.

The manufacture of tile in Europe was begun during the twelfth century. Because it had to be made by hand, tile was expensive, and its use was confined mostly to the great cathedrals of the Old World.

Most early American tile had to be imported at considerable cost. These tiles were used chiefly for the construction of mantels.

As tile manufacturers began to use modern American industrial techniques, tile products came within the means of the average homeowner. The extensive use of tile in homes, such as in bathrooms, kitchens, and utility rooms, is a comparatively recent development.

Tilework is installed not only in homes, but also in most public and commercial buildings. Tilework is used in swimming pools, showers, hospital surgery rooms, chemical laboratories, dairies, and meat processing plants.

Surprisingly enough, tile has been successfully manufactured in this country only since 1876, when Samuel Keys, an English immigrant, had the foresight to see tilemaking as a productive industry. He set up America's first large-scale tilemaking plant. He had begun experimenting with tile while operating a brick kiln in Pittsburgh, Pennsylvania. Within a few years, other plants sprang up in Ohio, New Jersey, New York, and Pennsylvania.

The growth of the American tile industry was accelerated in the 1920s. The great building boom of those years was accompanied by a revolution in the living habits of the average American. Throughout the nation, builder after builder turned to the use of tile as a sanitary, waterproof material, which made the perfect finish for such things as modern bathrooms, drainboards, and mantels.

Scope of the Trade

Throughout the four-year apprenticeship, the apprentice tilesetter will be receiving such instruction and experience in all branches of the trade as are necessary to develop a practical and skilled tilesetter. Particular emphasis will be placed on the study of blueprints. The apprentice will also perform other duties that are commonly related to this apprenticeship. The trained craftsperson today must know how to lay out work of all kinds and repair (patch) all installations. The journey-level tilesetter may be required to work on circular columns, arches, and domes, as well as fountains and stairs. Materials used in the trade are not always glazed wall tiles or ceramic mosaics; they may be cement tiles, glass mosaics, smalti-type glass mosaics, or ceramic veneers.

The new apprentice may be expected to mix mortar and soak tiles, to rough-in jobs with metal lath and tar paper, and to dampen and peel the paper from ceramic mosaic tiles. Some of these jobs may seem simple, but they are a necessary adjunct to the training of apprentices.

For the apprentice's related training instruction, some schools are able to provide special mock-ups of pullmans, drainboards, stairs, and columns to work on. The first year as an apprentice is usually spent on work requiring little layout and easy execution. As the apprentice progresses, the work becomes more difficult. During the final year, the apprentice should be able to complete a specific number of projects on mock-ups in class. Throughout the course, competent instructors with years of experience working in the trade will give practical demonstrations and answer questions that the apprentice may encounter on the job.

When the apprentice has completed the training, he or she will be accepted as a journey-level worker with the wage scale of a trained mechanic and the responsibility of a skilled craftsperson. The journey-level tilesetter will be recognized by employers in the industry as a skilled worker and will be able to instruct other apprentices.

Recommended standards for the tilesetting trade list the following major processes to be included in the apprenticeship agreement:

- Preparing surfaces to be tiled
- Floating, screeding, and scratching surfaces
- Performing layout work of all kinds
- Setting all types of tile
- Doing thin-set installations of all kinds
- Reading blueprints, from simple shop drawings to the commercial type required for schools and industrial buildings
- Setting tile on walls, floors, ceilings, drainboards, showers, mantels, swimming pools, domes, and arches
- Repairing existing installations
- Removing existing work and replacing with new

UNIT A — INTRODUCTION TO THE TRADE

TOPIC 1 — HISTORY AND SCOPE OF THE TRADE

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The __1__ were the first to develop tilemaking to an art. 1. ________

2. The __2__ used tiles for keeping permanent records. 2. ________

3. The apprentice will be expected to mix mortar and rough-in jobs with metal __3__ and tar paper. 3. ________

4. Preparation of surfaces is mentioned in the list of major processes to be included in apprenticeship __4__. 4. ________

5. The first large-scale tilemaking plant in America was in __5__. 5. ________

6. The growth of the American tile industry was accelerated in the __6__. 6. ________

7. Learning how to read __7__ is an important part of the apprentice tilesetter's training. 7. ________

8. In the third year of training, the apprentice should complete a specific number of projects on the class __8__. 8. ________

9. The manufacture of tile in Europe was begun during the __9__ century. 9. ________

10. Colorful glazes were perfected by the __10__. 10. ________

UNIT A — INTRODUCTION TO THE TRADE

TOPIC 2 — SAFE WORKING PRACTICES

This topic is planned to provide answers to the following questions:

- **How important is on-the-job safety?**
- **What agency has the responsibility for enforcing California's industrial safety regulations?**
- **What special safety precautions must be observed in tilesetting work?**

Tilesetting may not appear to be a particularly hazardous trade; however, one should consider some of the equipment the tilesetter uses—the electric saws and drills, the flammable and toxic mastics and epoxies, and the scaffolds required for many jobs. Any or all of these present a variety of hazards. In addition, at every construction site hazards exist that can cause injuries to workers.

No one can point out all the possible sources of trouble on a construction job. Each worker must develop safety awareness.

Enforcement of Safety Regulations

An important safety principle is that accidents can be prevented. Safety regulations are written and adopted as a means of making accident control more effective. In California, the Division of Occupational Safety and Health in the State Department of Industrial Relations has the responsibility for administration and enforcement of state laws relating to safety in employment. It surveys places of employment, investigates disabling or fatal industrial injuries, prepares safety standards, and establishes and enforces safety regulations.

California's Occupational Safety Orders

The Division of Occupational Safety and Health establishes minimum standards of safety, or safety orders, for all phases of industrial activity. The *General Industry Safety Orders* are general in application. Other categories of safety orders, like the *Construction Safety Orders*, apply to specific industries or phases of industry. Proposed safety orders, or revisions to existing safety orders, are adopted only after they have been fully studied by safety engineers, labor leaders, employers, workers, and other interested persons, and have been approved by the Occupational Safety and Health Standards Board.

The *Construction Safety Orders*, which are published in convenient handbook form, establish minimum safety standards for work connected with the construction, alteration, painting, repair, maintenance, renovation, removal, or wrecking of any fixed structure or its parts. The handbook includes safety regulations and specifications affecting workers and employers, and a copy should therefore be available on the job at all times.

Occupational Safety and Health Act

A new federal act governing on-the-job safety—the Williams-Steiger Occupational Safety and Health Act, better known as OSHA—became effective in 1971. The purpose of OSHA is to ensure so far as possible that every worker in the nation will have safe and healthful working conditions and to preserve human resources. This law applies to all the states and U.S. territories, but it provides that the states may develop their own plans for meeting the requirements of the law.

Immediately after OSHA became effective, California entered into an interim agreement with the federal government by which California could continue to enforce its own safety program until it could come up with a plan that was at least as effective as the federal plan. With a federal planning grant, California began a line-by-line comparison of the federal OSHA program and the state safety program in an effort to align state safety standards with the federal standards. In September, 1972, California submitted its occupational safety and health plan to the U.S. Department of Labor. The plan was approved in May, 1973.

California Occupational Safety and Health Act of 1973

The material in this section is a summary of the provisions of the California Occupational Safety and Health Act of 1973, which became fully operational in 1976.

Purpose

The California Occupational Safety and Health Act of 1973 (CAL/OSHA) was enacted (1) to ensure safe and healthful working conditions for all California working men and women through enforcement of effective standards; and (2) to help employers to maintain safe and healthful working conditions in their places of employment.

Administration

The administration of the CAL/OSHA plan is the responsibility of the California Agriculture and Services Agency. All authority to make and enforce rules is vested in the California State Department of Industrial Relations through its Division of Occupational Safety and Health.

In enforcing all standards and the *Construction Safety Orders,* the Division of Occupational Safety and Health may do any of the following:

1. Declare and prescribe what safety devices are well adapted to ensure safety and safe places of employment for employees.
2. Enforce standards and orders adopted by the Occupational Safety and Health Standards Board for the installation, maintenance, and operation of safeguards.
3. Require the performance of any act reasonably required for the protection and safety of employees.

Inspections

When the Division of Occupational Safety and Health learns or has reason to believe that any place of employment is unsafe, it may, on its own motion or upon receiving a complaint, conduct an inspection with or without a notice or hearing. Only the division chief or an authorized representative has the authority to permit advance notice of an inspection. When an inspection is to be made as a result of an employee complaint, advance notice will be given only in those cases involving imminent danger to an employee.

After presenting appropriate credentials to the employer, division representatives must have free access to any place of employment for the purpose of making an inspection or investigation; any person who obstructs or hampers such action is guilty of a misdemeanor.

Representatives of both the employer and the employees have the right to accompany any division representative during an inspection. Safety violations or problems can be discussed at that time. If an employee representative is not designated, the inspector may consult with a reasonable number of employees during the inspection.

Citations

When the Division of Occupational Safety and Health determines through its inspection that an employer has violated any standard, rule, order, or regulation, the division should issue a written citation as soon as possible after the violation; however, the citation must be issued within six months of the occurrence of the violation, and a copy of each citation issued must be posted for three days or until the unsafe condition is abated, whichever is longer. In the case of citations issued for serious violations, the division must reinspect at the end of the period of abatement.

Investigations

The Division of Occupational Safety and Health will investigate the causes of any fatal accident or of any accident that results in a serious injury to five or more employees. (The term *serious injury* will be defined in a later section.) The division also may investigate the causes of any other employment-related accident or illness that has caused or could cause a serious injury.

The Bureau of Investigations within the Division of Occupational Safety and Health is responsible for directing investigations of accidents that involve violations of standards or orders, serious injury, death, or a request for prosecution by a division representative. The preparation of cases for prosecution will be handled by the Bureau of Investigations.

The authorized representatives of the bureau have the right to enter all places of employment to conduct their investigations, and they may collect any evidence they deem necessary. The results of an investigation will be referred for appropriate action to the city attorney or district attorney having jurisdiction over the case.

Complaints

When an employee files a complaint with the Division of Occupational Safety and Health that a place of employment is unsafe, the division must investigate the complaint within three working days, with or without notice or hearing. If several complaints are to be investigated, those involving serious hazards will be given priority. Action against employees subsequent to their complaining of unsafe conditions is forbidden under CAL/OSHA, and the name of any person filing a complaint must be kept confidential upon the request of the complainant.

No employee can be laid off or discharged for refusing to work where any safety or health standard is violated and where such violation creates a hazard to the employee or a fellow worker. An employee who believes that he or she has been discharged unfairly or otherwise discriminated against may file a complaint with the Labor Commissioner.

Restrictions for Hazardous Conditions

If the condition of any place of employment or the operation of any piece of equipment constitutes a serious hazard to employees, the Division of Occupational Safety and Health may ask the courts to issue an injunction that would restrain operations until the hazardous condition is corrected. The division may also prohibit entry into the place of employment, or it can forbid the use of the equipment. Notice of such action by the division must be posted in a conspicuous place in or at the place of employment. An authorized representative of the Division of Occupational Safety and Health may remove the notice at such time as the place of employment or piece of equipment has been rendered safe.

Safety Notices

A responsibility of the staff of the Division of Occupational Safety and Health is to prepare safety notices for employers to post in their places of business. The safety notices should contain pertinent information about safety rules and regulations, the location of the nearest division office, the employees' rights, and any other information the division deems necessary. The division must ensure that these notices are printed in both English and Spanish. Regulations on the content of safety notices, their location, and the number to be posted by employers are made at the discretion of the division.

Occupational Safety and Health Standards Board

The agency responsible for occupational safety and health standards and orders in California is the Occupational Safety and Health Standards Board within the Department of Industrial Relations. The board consists of seven members appointed by the Governor. All meetings held by the board are open to the public, and notice of the meetings must be published in major newspapers throughout the state.

In helping to enforce occupational safety and health standards, the State Department of Health Services will do the following:

1. Help inspect specific places of work to evaluate occupational health programs or environmental conditions that may be harmful to the health of employees.
2. Upon request and under certain circumstances, conduct special investigations of occupational health problems that are unrelated to any specific enforcement action.
3. Provide for safety engineers of the Division of Occupational Safety and Health a continuing program of training in the recognition and handling of health hazards.

Safety Education

The Division of Occupational Safety and Health is directed to maintain a program of education and research to provide the following:

1. In-service training for division personnel
2. Safety education for employers and employees
3. Research and consulting services to any employer or employee group requesting such services

The division is responsible for preparing and distributing information concerning occupational safety and health programs and methods. Safety training programs will be provided upon request, but priority for the development of training programs will be within those occupational areas where the greatest hazards exist. Consulting services include furnishing information, advice, and recommendations for maintaining safe and healthful work practices.

Employer and Employee Responsibilities

Every employer must furnish employment and a place of employment that are safe and healthful for the employees. The employer must furnish and require the use of necessary safety devices and safeguards and must adopt and use work practices and processes that are adequate for the safety and health of the employees. Under no circumstances can an employer require or permit an employee to work where safety and health standards are not met.

Each employee, as well as every employer, must comply with safety and health standards and with all rules, regulations, and orders that are applicable to his or her own actions and conduct. No person may do any of the following:

1. Remove, displace, or destroy any safety device, notice, or warning.
2. Interfere in any way with the use of any safety device by another person.
3. Interfere with the use of any method or process adopted for the protection of any employee.
4. Fail or neglect to do everything reasonable to protect employees.

Information Provided by Employers

Under prescribed conditions each employer must provide the employees with specific information pertaining to their safety on the job. To comply with this requirement, employers must do the following:

1. Post information regarding protection and obligations of employees under occupational safety and health laws.
2. Post prominently each citation issued.
3. Provide the opportunity for employees or their representatives to observe monitoring or measuring of employee exposure to hazards.
4. Allow employees or their representatives access to accurate records of employee exposures to potentially toxic materials.
5. Provide notification to any employee who has been or is being exposed to toxic materials in levels exceeding those prescribed by an applicable standard, order, or special order; and inform any employee so exposed of the corrective action being taken.

Serious Injury or Illness

Serious injury or illness is defined as any employment-related injury or illness that (1) requires inpatient hospitalization for a period in excess of 24 hours for other than medical observation; or (2) causes an employee to suffer the loss of any member of the body or any serious degree of permanent disfigurement. Injuries resulting from a violation of the California State Penal Code (except Section 385) or from an accident on a public street or highway are not within the jurisdiction of the Division of Occupational Safety and Health.

Variations from Standards

With approval from the Occupational Safety and Health Standards Board, an employer may be granted a variance from a prescribed regulation.

Permanent variance. To receive a permanent variance, an employer must satisfy the board that an alternative program or method of equal or superior safety will be provided for the employees.

Temporary variance. A temporary variance can be granted by the Standards Board if an employer establishes that:

1. The prescribed standard cannot be complied with by the effective date because resources cannot be located.
2. Everything possible is being done to safeguard the employees against hazards covered by the regulation in question.
3. An acceptable program for complying with the regulation will be established as quickly as possible.

Project Permits

Some types of work involve a substantial risk to employees. In these special cases an employer must be issued a permit by the Division of Occupational Safety and Health prior to the beginning of the work. Some examples of work for which the division must issue project permits are: (1) construction of trenches or excavations that are 5 feet (1.5 metres) deep or more and into which a person is required to descend; (2) construction of any building, structure, falsework, or scaffolding work more than three stories high; and (3) demolition of any building, structure, falsework, or scaffolding more than three stories high.

Appeals

Any employer who is served with a citation has the right to file an appeal with the Occupational Safety and Health Appeals Board, which consists of three members appointed by the Governor to represent management, labor, and the general public. Each member is appointed to serve a term of four years.

An employer who receives a citation or a notice of a civil penalty may submit an appeal to the Appeals Board within 15 working days of the date on which the citation or notice was received. The appeal may be made with respect to alleged violations, abatement periods, or the amount of proposed penalties.

Within 30 days after a case is submitted, the Appeals Board or a hearing officer will make a decision on the appeal and will file an order or decision. Persons affected by this order or decision may, within the time limit specified, apply to the superior court for a writ of mandate for the purpose of determining the lawfulness of the original order or decision or the lawfulness of the order or decision following reconsideration.

Keeping Informed

A complete text of the California Occupational Safety and Health Act is available from the Division of Occupational Safety and Health, 445 Golden Gate Ave., San Francisco, CA 94102.

Safe Working Practices

The foundation of good safety practices is built upon a knowledge of basic safety principles and rules, but these general rules must be made specific if they are to be of practical value; in other words, they must be related to actual conditions on the job. The specific safety rules that are presented in the following paragraphs are important. Violations of such rules figure in many industrial accidents.

Practicing Good Housekeeping

Good housekeeping is essential for safety on the job. Floors, aisles, stairways, and ramps must be kept clear of materials, tools, ropes, electric cords, and trash. Work areas must be kept clean and clear of unneeded materials and equipment. Oil, grease, mud, or other substances that could cause falls must be cleaned up immediately. Any material or object that could be stumbled over should be removed from the work area or guarded if it cannot be removed. Form and scrap lumber with protruding nails should be kept away from work areas and passageways. Protruding nails should be pulled out or bent flat. The ground within 6 feet (1.8 metres) of a building or work area must be leveled, and depressions must be filled in or guarded. Open ditches must be bridged. Adequate illumination must be available for work areas and passageways, and enclosed spaces must have adequate ventilation; illumination and ventilation devices therefore must not be obstructed.

Wearing Appropriate Clothing

The worker should wear clothing that is appropriate for the work. Pants legs with torn, bulky, or turned-up cuffs may catch on a projection and cause a fall. Shoes that have thick soles and good heels reduce the possibility of injury from stumbling or slipping or from sharp objects that might puncture the foot.

Clothing that offers real protection is particularly important when the new epoxies and mastics are being used. These materials can be irritating to the skin.

Using Protective Equipment

The worker must use the safety equipment that is provided. The *Construction Safety Orders* require that eye protection be provided to workers who are chipping and repairing old work or setting fasteners in concrete. The worker's eyes should be protected not only from flying pieces but also from the fine dust that accompanies such work. In addition, respiratory or dust-filtering equipment is recommended for use when needed. Lanolin or other protective ointments can be used on the skin to prevent cement dermatitis or allergic reactions to epoxies. Gloves may be worn, but they must be replaced if they become contaminated on the inside. A hard hat should be worn when construction is going on overhead. Goggles should always be worn when tile is being cut with a power saw. Long hair should be tied back and/or protected.

Handling and Piling Materials

Incorrect handling and piling of materials may result in a serious accident. Piles of lumber, structural steel, and the like should be made stable with headers or crosspieces in the pile to prevent slipping or tipping. Piles of brick, tile, building blocks, and the like should have headers at least every sixth course; and when such a pile is over 4½ feet (1.4 metres) high, it should taper back 1 inch (2.5 centimetres) to each foot (30 centimetres) unless other effective means are employed to stabilize it. When cement or other sacked materials are to be piled more than 5 feet (1.5 metres) high, any unsupported face of the pile must be tapered back (pile faces may be supported by walls or other effective means). Materials must never be piled where they will interfere with or prevent the use of fire extinguishers, hoses, lights, or exits.

When handling materials, workers should protect their hands with leather gloves or hand leathers. Whenever the gloves become contaminated on the inside, they should be replaced.

The handling of dangerous materials, such as explosives, radioactive materials, chemicals, and flammable materials, is strictly regulated.

These materials should be moved only by persons who have been instructed in the safe handling of such materials.

Mixing of materials should be done in a well-ventilated area. A well-ventilated area can reduce the breathing in of silica dust during the mixing operation. The mixing of some products must be done in the proper sequence. The manufacturer's instructions should be followed. Ignoring the instructions could result in dangerous and/or explosive mixtures. When acid is being used, it should be poured into the water.

Lifting Materials

Unsafe methods of lifting, lowering, and carrying materials can cause strains, sprains, and hernia. If the strain is exceptionally severe, dislocations and even fractures can result. When coupled with unsafe working conditions, such as wet and cluttered floors or dark and narrow passageways, lifting and carrying can result in bad falls or smashed fingers or toes.

The worker should not try to lift or carry heavy loads without help. Simple equipment that can be used for lifting or carrying such loads includes rope-and-pulley hoists, rollers, counterweights, dollies, trucks, and tote boxes.

Coordinated teamwork is necessary when two or more persons are to work together in lifting or carrying. Work partners should be of similar build if possible. The direction they are to move, the timing of the lift, and the timing of placing and releasing the load must be agreed upon, but only one member of the team should give directions. Work partners should keep in step when carrying a load.

Using Hand Tools

Incorrectly used or poorly maintained hand tools are dangerous. The chief hazards associated with hand tools are the following: being struck by the tool being used or by a tool used by another worker; being struck by chips from a tool or from the material it is used upon; being struck by a tool that has come off its handle; and stumbling over or being cut or hit by a tool carelessly left on the floor, on a workbench, or on a scaffold.

A worker is in danger of being injured by a tool if it is the wrong one for the job, if it is the right tool used in the wrong way, or if it is defective. A file will almost certainly break if it is used as a prying tool, and it can inflict a severe puncture wound if it is used without a handle. A dull chisel or other cutting tool is more likely to slip than to cut.

Before swinging a hatchet, sledge, or similar tool, the worker should ensure that no other person is close enough to be struck. The heads of hammers and similar tools must be kept tight on their handles.

If the head of a tool becomes mushroomed, it may chip during use, and the flying chip may penetrate an eye or cause other serious injury. Mushroomed tool heads should be reground. Overhardened tools present the same hazard—they are brittle and tend to chip or break in use.

Any tool not in use should be returned to the toolbox or stored in a safe place. Tools that are carelessly left lying about in work areas are common causes of industrial accidents.

Almost all injuries that occur while using hand tools would be avoided if a few basic rules were followed. These are the following:

1. Use the right tool for the job.
2. Learn how to use the tool correctly.
3. Keep tools in their best condition.
4. Keep each tool in its place.

The proper tools should be used for mixing or applying materials. The hands should not be used for such operations. Dirty tools should not be allowed to contaminate clothing with wet cement, epoxy, or mastics that may cause a skin reaction.

Working with Electrical Equipment

The tilesetter may be required to operate tile saws or grinders that are powered by electricity. Electric shock is always dangerous. The shock alone could be serious and, under certain conditions, may even be fatal.

Electric shock results when all or part of the body becomes part of a live electric circuit. A shock can occur only if the electric current finds a path through the body, entering at one point and leaving at another. The intensity of the shock depends upon how much current passes through the body, which in turn depends upon two factors: the voltage (electrical pressure) impressed across the body and the electrical resistance of the body at the moment of the shock.

All electrical service wiring incorporates one or more live or "hot" conductors and a neutral or "return" conductor. The neutral conductor is connected to earth ground. Shock will result if the worker does any of these things: (1) simultaneously comes in contact with a live conductor and a grounded object or surface, such as a utility pipe, a damp floor, or the earth itself; (2) simultaneously touches a live and a neutral conductor, for instance, by grasping both exposed conductors of a badly frayed power cord; or (3) while in contact with the ground or a grounded object, touches a metallic object that has itself become "hot" through contact with a live conductor.

Most electric shocks result when a person touches a live conductor while touching or standing on a grounded object or surface. The severity of an electric shock is much increased if the worker's hands or feet are wet. Water or perspiration reduces the electrical resistance of the body and allows more current to flow through it. Conversely, any dry insulating material that is placed between the body and ground or between the body and the live conductor will prevent or reduce the severity of the shock. Rubber, wood, cloth, and other nonmetallic materials are good electrical insulators if they are dry; wet insulating materials are ineffective.

The severity and extent of the injury resulting from electric shock are determined in part by the path the current takes through the body. If the current affects the vital organs, particularly the heart or lungs, the probability of severe injury is much greater than if it is confined to a finger or a hand. The duration of the shock and the physical condition of the victim also affect the degree of injury.

The first duty of a person reaching a victim of electric shock is to remove him or her from contact with the energized wire or equipment, being careful not to contact either the victim or the energized object. The power must quickly be turned off if the switch is nearby, but no time should be lost in looking for the switch. A stick, board, rope, article of clothing, or other nonconducting object can be used to free the victim from the wire, but the thing used must be dry and the rescuer must be standing on a dry, nonconducting surface. A standard resuscitation procedure should be started immediately after an unconscious victim of electrical shock has been separated from the energized object, and a doctor should be called as soon as possible. Resuscitation should be continued until the victim is breathing normally or until a competent medical authority gives the rescue worker other instructions.

The insulation on conductors must be in good condition, and all noncurrent-carrying metal parts of electric tools and power machines must be grounded. The danger of electric shock can be held to a minimum if the following rules are observed:

1. Consider all electric wires live unless they are known to be otherwise.
2. Do not work with electrical circuits unless you are qualified and authorized to do so.
3. Do not make repairs to electrical equipment unless you are qualified and authorized to do so.
4. Double-check to ensure that main switches are off before working near electrical conductors or other potentially "hot" electrical components. (Only qualified and authorized persons should touch electrical components.) Lock the switch box, and place a warning sign on it to ensure that the main switches will not be turned on by another person.
5. Be sure your hands are dry. If you must work on a wet surface, wear rubber-soled shoes and rubber gloves.
6. Use only heavy-duty extension cords, and inspect them each time for damaged insulation and fittings.
7. Do not hang or bend an extension cord across nails or sharp surfaces. Do not leave a cord where it can touch wet cement or a truck can run over it.
8. Make sure that all portable electrical tools, such as the tile saw and drill, are grounded. If a ground has not been built in, use an extra wire to ground the tool casing to a water pipe.

Working on Scaffolds

Tilesetting generally is considered a light trade. The apprentice tilesetter should be thoroughly familiar with the minimum state requirements for light trades scaffolds; however, some of the tilesetter's work approaches that of the heavy trades—such as installing marble tile on exterior facades. When doing that work, the tilesetter should be aware of the safety requirements for scaffolds used in the heavy trades.

Anyone who is subject to dizziness or fear of falling should not try to work at elevations. Those persons who know they cannot work at a height should notify their supervisor.

Scaffolds must be provided for all work that cannot be done safely by workers standing on permanent or solid construction. Elevated platforms, scaffolds, and stairwells must have railings.

Specifications for safe scaffolds are given in California's *Construction Safety Orders,* and these must be followed exactly. The general requirements are that scaffolds must provide adequate strength, rigidity, and safety and that they must be anchored and braced to prevent swaying, tipping, or collapsing. Scaffolds that are 7½ feet (2.3 metres) or more above the ground, floor, or level underneath must have railings on the open sides and ends. The number of persons that can safely occupy a given scaffold must be made known to the workers on the job. They should strictly observe the stated load limitation. The amount of material that can be supported safely by the scaffold must also be stipulated, and this limitation too must be fully respected. Suitable protection must be given to those working immediately below scaffolds. Like all other scaffolds, horse scaffolds (platforms or boards laid across wooden horses) are subject to regulations requiring their substantial construction and bracing.

Using Elevators and Hoists

Construction material elevators and hoists are used only for carrying material, not for carrying passengers. No one should be permitted to ride in them except to oil or repair guides.

Observing Special Precautions

Early in the training period, the tilesetter should be made aware of the special safety hazards of the trade.

The tilesetter often must work on damp surfaces that may cause a bad fall. The wet mortar, which may contain active lime, can injure the eyes or skin.

The epoxies and mastics used by the tilesetter are particularly hazardous. Most of them are flammable, toxic, and irritating to the skin. When these materials are being used, the *Construction Safety Orders* require that the following precautions be taken:

1. Ensure that epoxies and mastics are properly labeled.
2. Read the labels carefully.
3. Use epoxies or mastics in areas where the ventilation is adequate, and avoid prolonged breathing of fumes. If electric fans are used, they should be the nonsparking type.
4. Avoid prolonged contact with the skin; if any of the material does contact skin, wash immediately with plenty of water.
5. Do not use epoxies or mastics in a room that contains an open flame.
6. Wash hands thoroughly after using these materials, particularly before eating.

Whenever clothing becomes saturated or impregnated with flammable liquids, corrosive substances, irritants, or oxidizing agents, the worker should remove the affected articles promptly and ensure that they are cleaned properly (*Construction Safety Orders,* Section 1522c).

Where the occupational duties of employees expose them to certain irritants, materials for the proper cleansing of the skin may be required for the prevention of skin disorders. Depending upon the problem, these materials may be in the form of ordinary soap and water or special compounds that are designed specifically for the removal of irritants from the surface of the skin (*Construction Safety Orders,* Section 1522d).

As a final reminder, the tilesetter should be on the alert at all times for heavy trucks backing into the work area. Although the driver of the truck is required to sound a warning device, nearby construction noise may prevent other workers from hearing the device.

Maintaining Personal Hygiene

Health hazards in the ceramic tile industry are primarily those that affect the skin, lungs, and eyes. Each individual should use the common sense approach to personal hygiene. Wearing clean clothing every day, properly maintaining the protective devices used, and keeping skin and clothing free of potential irritants are personal responsibilities of the worker. Some materials in the wet or uncured stage may act as skin irritants. Inhalation of some powdered ingredients may cause lung problems. The eyes also may be affected by irritants. Cleaners should be used that are not of themselves harmful. Soaps or cleaners that are made especially for the removal of cement or resinous material should be used. Such solvents as acetone or gasoline should never be used to clean hands.

Reporting an Accident

When an accident occurs, a report must be made of any injury that is sustained, no matter how slight.

A first-aid kit should be available at the jobsite. Small cuts or abrasions may seem of little consequence; but if they become infected, they can be as serious as a major injury. A cut should be disinfected as soon as it occurs. If a worker is injured in an accident, first aid should be administered, and a doctor should be called. When an accident results from a hazardous condition that is correctable, the condition should be brought to the attention of the supervisor and be corrected.

Study Assignment

Construction Safety Orders (Latest edition). Sacramento: California State Department of Industrial Relations, Division of Occupational Safety and Health. Read articles 1 through 4, 14 through 30, and 33 and 34.

American National Standard ANSI A10-20-1977 (Latest edition), "Safety Requirements for Ceramic Tile, Terrazzo, and Marble Work." Read portion on ceramic tile.

Note to Instructor

Arrangements may be made with a local Red Cross chapter to have an instructor in first aid visit the class to demonstrate the treatment of injuries.

UNIT A — INTRODUCTION TO THE TRADE

TOPIC 2 — SAFE WORKING PRACTICES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. When lifting heavy objects, a person should use the strong muscles in the 1 and 2 .
   1. ________
   2. ________

2. Epoxy should be washed off the skin immediately with 3 .
   3. ________

3. Epoxies and mastics are safety hazards because many of them are toxic, 4 , and irritating to the skin.
   4. ________

4. In connection with the scaffolding to be used, tilesetting generally is considered a 5 trade.
   5. ________

5. To pull a person free from contact with a live power line, a(n) 6 7 should be used.
   6. ________
   7. ________

6. When they are chipping tile, tilesetters should protect their eyes from flying pieces and from 8 9 .
   8. ________
   9. ________

7. Wet cement is injurious if it contains active 10 .
   10. ________

8. The California Occupational Safety and Health Act (CAL/OSHA) encourages employers to maintain 11 and 12 working conditions.
   11. ________
   12. ________

9. Periodic inspections at the job site are made by trained 13 14 from the Division of Occupational Safety and Health.
   13. ________
   14. ________

10. A worker should 15 to perform work that would 16 safety orders.
    15. ________
    16. ________

11. Where working partners are carrying a load, they should keep in 17 , and only one should give 18 .
    17. ________
    18. ________

12. Elevated platforms, scaffolds, and stairwells must have 19 .
    19. ________

13. Simultaneous contact with 20 electric wire and any 21 will result in a shock.
    20. ________
    21. ________

14. If a worker's hands or feet are 22 , the severity of an electric shock will be 23 .
    22. ________
    23. ________

15. Epoxies or mastics should not be used in a room that contains a(n) 24 25 .
    24. ________
    25. ________

TOPIC 3 — TRADE ORGANIZATIONS

This topic is planned to provide answers to the following questions:

- **What organizations have been formed to serve the tilesetting trade?**
- **What are the objectives of the Ceramic Tile Institute of America?**
- **Who writes installation and material specifications for the tile industry?**

The members of the tilesetting trade are served by numerous organizations. This topic presents information on the international union to which the employees belong, associations of which their employers are members, and other organizations that do research and promotional work for the tile industry.

Employee Organizations

Tilesetters belong to the International Union of Bricklayers and Allied Craftsmen (IUBAC). This name was recently changed from the Bricklayers, Masons and Plasterers International Union of America (BMPIUA), which was first organized in 1888. Then it was known as the Mosaic and Encaustic Tile Layers and Helpers International Union. It became affiliated with the American Federation of Labor (AF of L) in 1890 but was disbanded three years later. In 1896 the San Francisco Building Trades Council issued a charter to the Mantel, Grate and Tile Setters Union; however, this union was recognized in the San Francisco area only.

The Mosaic and Encaustic Tile Layers and Helpers International Union was reorganized at Nashville, Tenn., in 1897. At its biennial convention in 1901, the name Ceramic, Mosaic and Encaustic Tile Layers and Helpers International Union was adopted.

In October, 1916, the Bricklayers, Masons and Plasterers International Union of America joined the AF of L, and in February, 1917, the Building Trades Department of the AF of L recommended that it take over the tile layers union. This recommendation was upheld at the AF of L convention in Philadelphia in 1918, and the tile layers' charter was revoked.

The IUBAC meets in general convention biennially. The union also sends delegates to AFL-CIO conventions. The delegates participate in the program and have a voice in determining the general policies.

Business of general importance to the subordinate unions appears monthly in the *IUBAC Journal,* which is edited by the executive board of the international union. This journal is authorized by the union constitution to publish an account of all reported accidents incurred through faulty or insecure scaffolds.

Subordinate unions of the IUBAC have the power to govern their own apprentice programs subject to restrictions reserved to the international union. They keep a roll of all apprentices during the period of apprenticeship. The international union registers each apprentice at the time of indenture. The apprentice is assigned a registration number, which is in effect until the day he or she is initiated. The international union also issues to all subordinate unions a dues record for each apprentice.

Besides negotiating work agreements for the employees, local unions have the responsibilities of enforcing apprenticeship agreements, establishing minimum wage scales for each period of the apprenticeship, and adjusting the term of the apprentice training to a longer period if the apprentice has failed to progress sufficiently to deserve the wage granted journey-level tilesetters by employers.

Tilesetters unions belong to the local building trades councils. These councils are designed to coordinate the interests of the various building trades unions. In the larger centers the tilesetters send delegates to citywide policy organizations called central labor councils.

Employer Associations

The tile contractors have their own associations. The two largest such groups in California are the Tile Contractors Association of Northern California and the Associated Tile Contractors of Southern California. Sacramento, Fresno, San Diego, and San Bernardino also have associations. In addition, tile contractors can join larger groups that work on a statewide or areawide basis. The Western States Ceramic Tile Contractors Association serves tile contractors in the 13 western states.

These employer associations are formed to establish a code of ethics for the members and to bargain with the unions in their areas. Their constitution and bylaws make it mandatory that those who belong conform to wage levels and conditions agreed upon and written into an agreement.

The associations hold meetings to discuss mutual problems, exchange ideas, examine new materials, review promotional material, and conduct routine business.

Joint Employer-Employee Organizations

Each apprentice tilesetter should know about the joint employee-employer organizations that work for the benefit of the trade. These groups are comparatively new. They are being organized in a number of areas for the purpose of promoting quality tile installations.

The first such group to be successful in the industry started in Los Angeles in June, 1954, with Tile Layers' Local 18 and the Associated Tile Contractors of Southern California, under the name of the Ceramic Tile Institute (CTI). Institutes are now established in San Francisco, San Diego, and Sacramento; Phoenix, Ariz.; Portland, Ore.; and Seattle, Wash.

In 1962 the San Diego, Phoenix, and Los Angeles groups established the Ceramic Tile Institute of America. This organization serves all members of the ceramic tile industry. The organization's objectives are the following:

1. Advertise by direct mail or through trade publications, newspapers, radio, and other means to promote quality tile installations.
2. Distribute publicity on activities of the tile industry.
3. Promote education, using various means, such as newspapers, seminars, and visual aids.
4. Work with and serve on committees that are writing codes, such as the Uniform Building Code and Uniform Plumbing Code.
5. Conduct research to be certain that materials and methods used will be satisfactory.
6. Work with the construction and building departments of all governmental agencies on specifications and details for tile installations.
7. Disseminate technical information on job installation problems to members of the Ceramic Tile Institute and the construction industry.
8. Work with building and plumbing code authorities on matters pertaining to the best practices of installing tile.
9. Work with suppliers of tile, installation materials, and tile accessories to develop products that will ensure satisfactory installations.
10. Support CTI representation on all American Society for Testing Materials (ASTM) or American National Standards Institute (ANSI) committees that are concerned with ceramic tile, installation materials, and specifications.
11. Develop installation specifications where such are not already available.
12. Encourage union tile contractors and tilesetters' unions to accept installation and material standards.
13. Help overcome jobsite installation problems by providing a counseling service for a project prior to, during, and after the installation of tile.
14. Investigate job problems and distribute findings to the CTI members concerned in accordance with the Rules of Procedure.

Manufacturers' Associations

Manufacturers of tile and tile installation products have formed groups to promote their individual products. These associations also support research and development programs for new methods and techniques to promote the use of tile and related material. They also participate in writing specifications and standards for tile on a local and national level.

One such association is the Tile Council of America. The members of this group are 20 to 25 of the largest tile manufacturers in the United States. They publish technical tips on installing tile, write specifications, and promote the use of ceramic tile. They also support a research center at Princeton, N.J., to develop quality materials and improve installation methods.

TOPIC 3 — TRADE ORGANIZATIONS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Tilesetters unions belong to the local _1_ _2_ councils. 1. ________ 2. ________

2. The international union holds a convention every _3_ years. 3. ________

3. The tilesetters union is a part of the _4_ _5_ of _6_ and Allied Craftsmen. 4. ________ 5. ________ 6. ________

4. The Ceramic Tile Institute encourages contractors and unions to accept _7_ and _8_ _9_. 7. ________ 8. ________ 9. ________

5. The first successful tilesetters union in California was formed in the year _10_. 10. ________

Unit B
Tile, Materials, and Tools

TOPIC 1 — MANUFACTURE OF CERAMIC TILE

This topic is planned to provide answers to the following questions:

- **How are tiles manufactured?**
- **What specifications are used in the tile industry?**
- **How is moisture removed from tile?**

The tilesetter must have a thorough background in the time-tested materials and methods used in the tilesetting trade to be able to adapt them to the constantly changing demands of the building industry.

This unit includes information on tiles and the base materials, backings, and grouts that are needed for setting tiles. It also includes details on the tools used by the tilesetter and the inserts and accessories that often form a necessary part of the tile installation.

The apprentice should review the material on basic mathematics and basic tools in the *Introduction to Apprenticeship*. Each apprentice will have to know simple mathematics, such as addition, subtraction, multiplication, division, and fractions, before he or she can prepare the backings or mix the base materials and grouts in the correct proportions.

The information on specific tools required by the trade as given in this workbook is planned to supplement the discussion on tools given in the *Introduction to Apprenticeship*.

Tile Specifications

Before studying the topics in this unit, the apprentice must have an understanding of specifications, which are essential to the construction industry. Specifications form a legal document that must be followed in doing tilework and all other work on a project. A tilesetter can safely deviate from the specifications only if a written change order has been made by a responsible party, who is usually the architect, owner, or general contractor for the project.

Specification writing recently has become a separate profession. Specification writers have a nationwide professional organization known as the Construction Specification Institute.

Individual project specifications and standard specifications are written by trade groups. These are so important to tilesetters that they are used as reference material in this and succeeding units. The following explanation is given to help the apprentice understand the purpose of each.

American National Standard Specifications

American National Standard specifications have been prepared to serve as a guide for specification writers and to furnish them with all the information they need to write a tile specification for an individual job. A reference may be put into a particular job specification, such as the following: "All tile on this job shall have workmanship and application conforming to the American National Standard Specification A108.1-1976." The tilesetter must be thoroughly familiar with such specifications. He or she should know, for example, that Specification A108.1-1976 pertains to the conventional method of setting tile and that Specification A108.5 pertains to the thin-bed portland cement mortar method of setting tile. American National Standard specifications are developed by the American National Standards Institute (ANSI). This agency formerly was known as the American Standards Association (ASA) and the United States of America Standards Institute (USASI).

Standard Specification CTI-R3-101-62

The *Standard Specifications for Installation of Ceramic Tile with Water-Resistant Organic Adhesives* (CTI-R3-101-62) were developed by the Technical Committee of the Ceramic Tile Institute to provide standards that are compatible with California building codes.

Standard Specification CTI-R7-103-62

Ceramic tile floors are the most successful shower floors available, but they must be installed correctly. The *Standard Specifications for the Installation of Tile-Lined Shower Receptors* (CTI-R7-103-62) were developed in cooperation with the International Association of Plumbing and Mechanical Officials as a standard for the Uniform Plumbing Code.

Recommended Standard Specifications for Ceramic Tile

The nationally recognized standard for the manufacture and quality control of ceramic tile is *Recommended Standard Specifications for Ceramic Tile* (TCA 137.1-1976), which was published by the Tile Council of America. An improved and updated version of this standard was written by an industry committee and adopted in 1979 by the American National Standards Institute with a designation of ANSI 137.1-1978.

During the past 50 years, the ceramic tile industry has tried to provide specifiers, architects, and consumers with the best available information on the products of the industry.

American Society for Testing Materials Standards

In many places throughout this workbook, reference is made to the American Society for Testing Materials (ASTM). The volumes of books required to record all the items tested would fill many shelves, and they are stocked only by libraries, testing laboratories, and construction industry organizations.

The ASTM was formed because the construction industry needed a standardization of specifications and methods of testing. The organizational meeting was held in Europe in 1882, but the members from the United States soon decided they needed a separate organization and in 1902 incorporated the present society. It is so widely known that testing laboratories and all parts of the construction industry use the ASTM standards and testing procedures.

Tile-Forming Processes

Apprentice tilesetters will not be expected to manufacture tiles, but they should have a broad understanding of the materials and processes used in the trade.

Although tilesetters work with tiles made of a variety of materials—glass, marble, and cement, as well as those of ceramic origin—most of the work involves ceramic tiles. The manufacturing processes described in this topic are used in the production of ceramic tiles.

The principal methods of forming ceramic tiles are the dust-press process, in which the tile body is dried to almost a dust consistency before it is pressed into shape; the extrusion process, in which a slightly wetter tile body is forced through a specially shaped opening; the slush-mold process, in which a much wetter mixture is poured into molds; and the ram-press process, which is similar to the dust-press process but is for larger pieces.

Most wall tiles and trim shapes are dust-pressed. The tile body is a mixture of finely ground talc and natural clays, with different mixes used for different types of tile. The correct proportions of clays are mixed with water and passed into filter presses where excessive water is pressed out. This mixture is pulverized, dried, and then pressed into different tile shapes by steel dies mounted on hydraulic presses.

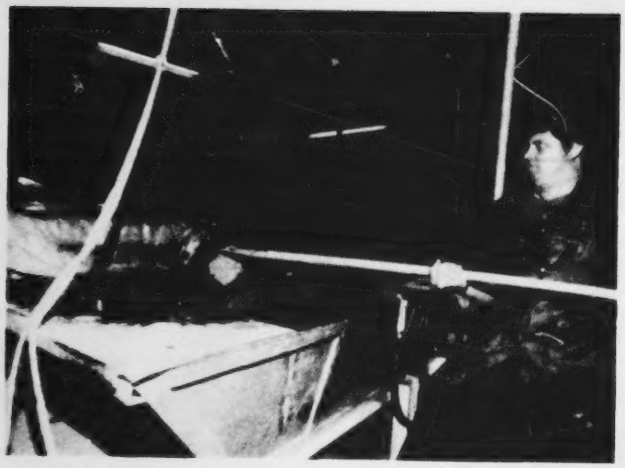
After it has been pressed, each tile is inspected for smoothness, size, and general imperfections. At this point it is called "green" tile. Some manufacturers use a process that requires two firings of the green tiles to attain the desired hardness and glaze. A patented process that requires only one firing for hardness and glaze application is used by other manufacturers. Both methods are described later in this topic. Regardless of the process used, the dust-press method places a limitation on the size and thickness of the tiles formed (Fig. B-1).

For the extrusion process, a mixture of clays, and sometimes shale, is proportioned with water to form a stiff mud. The mixture is put into a machine that extrudes and cuts it to the correct size. The pieces then are inspected for size and smoothness. Nearly all quarry tiles and some ceramic mosaic tiles are produced by this method.

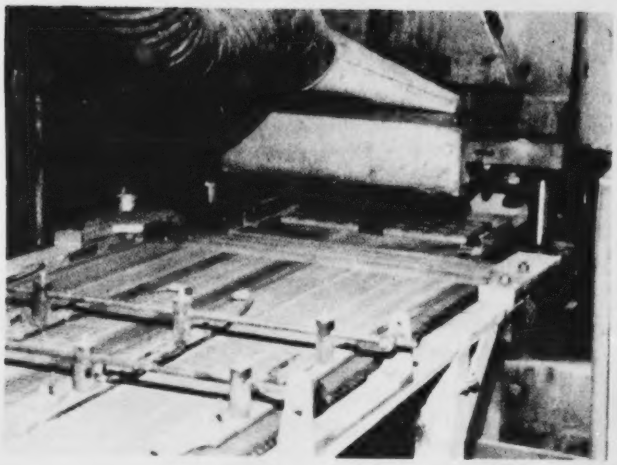
In the slush-mold process, a wet mixture of clay is poured into molds. After a period of drying, the molds are removed, and the tiles are placed in a kiln and fired at the desired temperature. The glaze usually is applied before firing.

In the ram-press process, two metal dies are used to form the green tile. The purpose is twofold: first, to get any desired shape, and second, to control the thickness. Two firings are required as in the dust-press process. The tolerances are the same as those for the dust-press method. The ram-press process is used mostly to make large pieces, such as ceramic veneers and some of the decorative tiles (Fig. B-2).

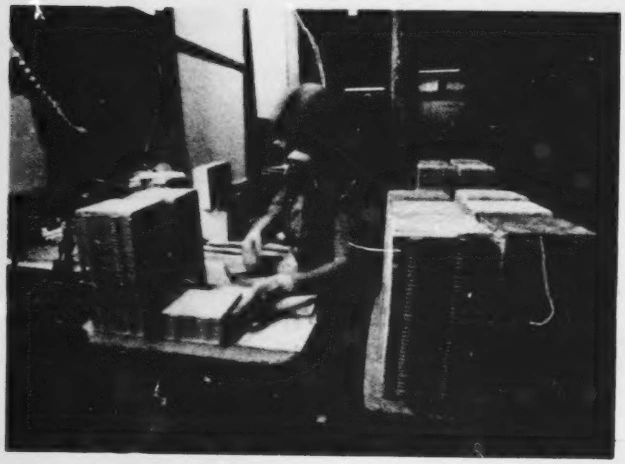
Other processes are used also, but those described above are the most widely employed. Generally



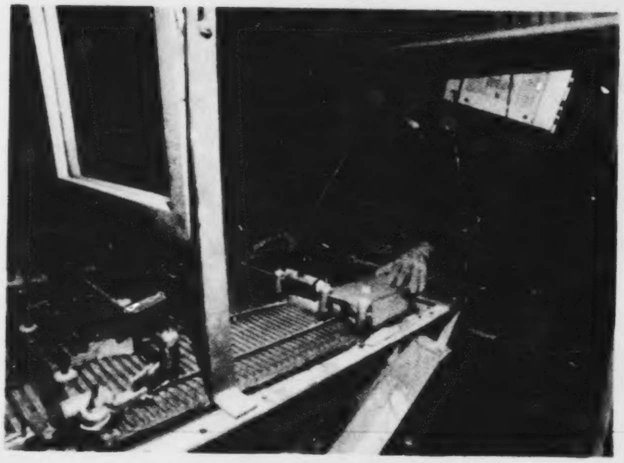
BATCHING TILE BODY



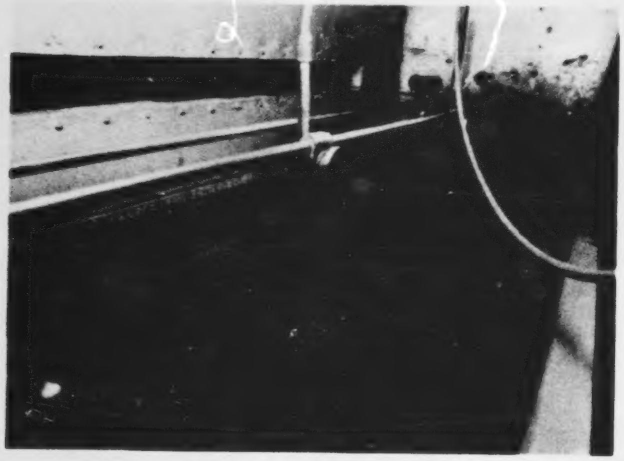
DRY PRESSING TILE



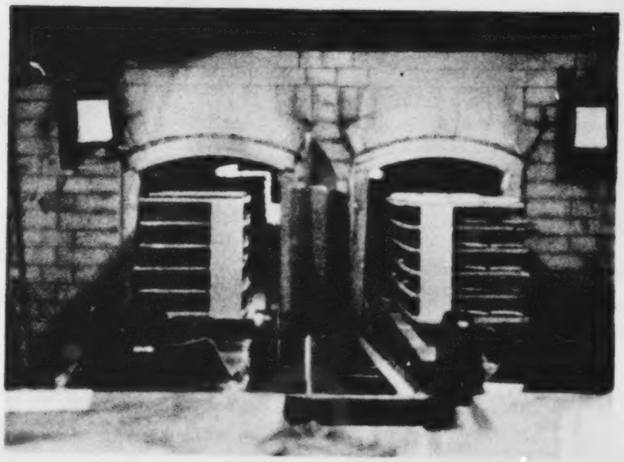
ASSEMBLING DUST-PRESSED TILE



REMOVING FEATHEREDGES FROM TILE



SPRAYING BISQUE WITH GLAZE



REFIRING IN TWIN-TUNNEL KILNS

Fig. B-1. Producing tiles by the dust-press process

speaking, the dust-press and ram-press processes are used where close tolerances of size are desired. Next in accuracy of manufacture is the extrusion method. The tolerances for it are close, but not as fine as those for the other two methods. In the slush-mold process, an uneven tile or one that has the appearance of being handmade is produced.

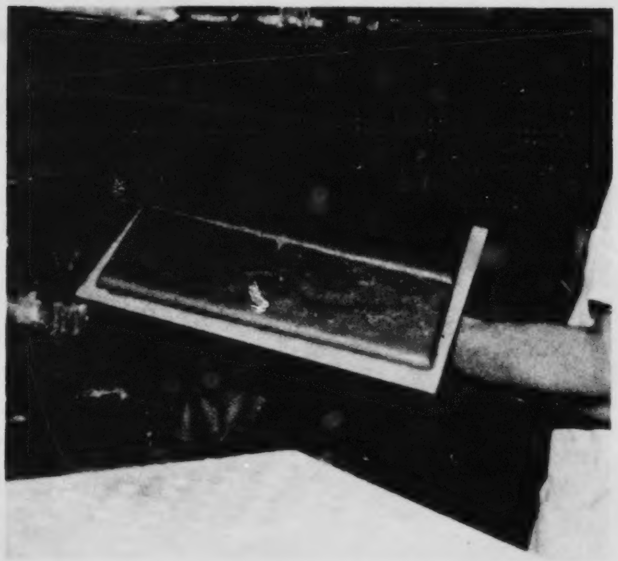


Fig. B-2. Ram pressing 6 by 12 inch (15.2 by 30.5 centimetre) tile

Firing Process

The degree of vitrification expressed concerning a tile indicates the percentage of moisture it will absorb. An impervious tile is one with an absorption level of less than 0.5 percent. Vitreous tile will absorb as much as 3 percent moisture; semivitreous tile will absorb more than 3 percent but less than 7 percent moisture; and nonvitreous tile will absorb more than 7 percent moisture.

Generally speaking, vitreous and semivitreous tiles are given a single firing. The colors are usually contained in the mixture of the tile body.

Glazes and colors usually are patented by individual tile manufacturers. Green tiles (which are fresh dust-pressed and ram-pressed tiles) are fired at a high initial temperature to form a "bisque" (any tile shape that is ready to be glazed). Following this, the glaze is sprayed onto the bisque, and a second firing at a lower temperature (glost firing) fuses the glaze with the bisque. The glazed finish and color are thus controlled at this glost firing. Tiles that are not glazed require only a single firing.

Tiles are given special decoration by the silk-screen process or by hand painting. Glazes are used to produce the color.

Grading Process

The grading of tile is based on surface blemishes, warpage, size, and general appearance. The grades are "standards" and "seconds." Those tiles that are not good enough to pass as standards or seconds are referred to as culls and normally are not used in tile installations. Culls are often crushed for roofing chips.

Tile Shapes

Wall tiles are made in squares, rectangles, triangles, hexagons, octagons, and circles. The shapes shown in Fig. B-3 are those most commonly used in the trade as determined by standard writing organizations and adopted by the standing committee on ceramic tile. Individual manufacturers also produce many other shapes. Apprentice tilesetters should study manufacturers' catalogs to familiarize themselves with what is available.

A comparatively new process eliminates a second firing for glazed wall tiles and trim shapes. After the green tile has been inspected and cured (that is, all moisture has been removed), the glaze is added to the face, and the tile is fired in the kiln, thus eliminating the bisque firing. The size and finish of the tiles are controlled by the amount of heat and the time spent in the kiln.

Study Assignment

Recommended Standard Specifications for Ceramic Tile (ANSI A137.1-1980). Read entire specifications.

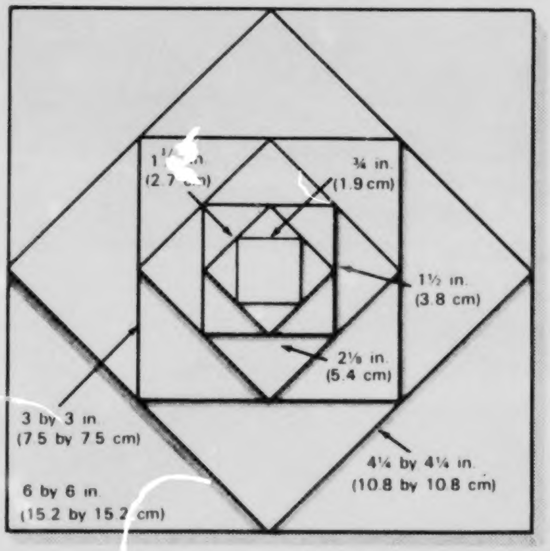


Fig. B-3. Modular breakdown of a 6 by 6 inch (15.2 by 15.2 centimetre) tile

TOPIC 1 — MANUFACTURE OF CERAMIC TILE

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. A bisque is a tile that has been fired __1__. 1. ________

2. After a tile has been pressed out, it is called a __2__ tile. 2. ________

3. Most of the tiles set by a tilesetter are of __3__ origin. 3. ________

4. Most wall tiles are made by the __4__-press process. 4. ________

5. For tiles that require more than one firing, the glaze is usually applied at the __5__ firing. 5. ________

6. Tile with water absorption of less than 0.5 percent is called __6__. 6. ________

7. Semivitreous tile has a degree of density that will absorb less than 7 percent of __7__. 7. ________

8. Most quarry tiles are produced by the __8__ process. 8. ________

9. A vitreous tile generally is given __9__ firing(s). 9. ________

10. The two grades of tiles sold commercially are standards and __10__. 10. ________

TOPIC 2 — TYPES OF TILE

This topic is planned to provide answers to the following questions:

- **What is quarry tile?**
- **How is faience tile used?**
- **What is paver tile?**

The origin of the word *tile* is in the Anglo-Saxon word *tigel*, which is a derivative of the Latin *tegula* from *tegere*, meaning *to cover*. Today, tiles are used as covering or surfacing for floors, walls, and ceilings, and for decorative and sanitary purposes on the interior and exterior of buildings.

To be a true professional, the tilesetter needs to understand the manufacture of tile and to have a thorough knowledge of the types and sizes of tiles. New trim shapes, colors, and designs are being produced constantly. Modern showrooms give the homeowner, builder, and architect a clear picture of the types of tile available and the appearance of the completed tilework. The tilesetter must keep up with the latest materials and methods of installation.

The different sizes of tile used today vary from the ⅜ by ⅜ inch (1.0 by 1.0 centimetre) paper-mounted mosaic tiles to the 16 by 18 inch (40.6 by 45.7 centimetre) glazed wall tiles. The combinations of shape, size, and color of tiles used are limited only by the imagination of the designer.

Major Types of Tile

The major types of tile are glazed wall tile, quarry tile, ceramic mosaic tile, and paver tile.

Glazed Wall Tile

Glazed wall tile (also called glazed interior tile) has a glass-like surface, usually classified as bright glaze; a matte finish; or a scratch-proof finish known as crystalline glaze (Fig. B-4). This tile is made by the dust-press method.

Quarry Tile

Quarry tile is usually unglazed tile made of natural clay or shale. It is vitreous, and it varies in size from 3 by 3 inches (7.6 by 7.6 centimetres) to 9 by 9 inches (22.9 by 22.9 centimetres) and in thickness from ½ to 1¼ inches (1.3 to 3.2 centimetres). The most commonly used sizes are 6 by 6 inches (15.2 by 15.2 centimetres) and 4 by 8 inches (10.2 by 20.3 centimetres). The color is contained in the clay and shale used in the body of the tile. It is manufactured by the extrusion method.

Quarry tile is very durable and is used where long service is desired (Fig. B-5). Different finishes are available to meet the different conditions encountered. Quarry tile is commonly used on the floors of kitchens and large food-processing plants and on patio and roof decks.

See color reproduction on page 119

Fig. B-4. Glazed tile installed on floor and fireplace hearth

Special-purpose quarry tiles are the ship and galley tile and packinghouse tile. The ship and galley tile is made with an indentation on the face to prevent slipping. Packinghouse tile usually is a little thicker than regular quarry tile.

Ceramic Mosaic Tile

Ceramic mosaic is a term generally used for unglazed dust-pressed tiles that are less than 2¼ by 2¼ inches (5.7 by 5.7 centimetres) (Fig. B-6). However, they are sometimes manufactured by the extrusion process, and they are also available with a glazed

See color reproduction on page 120

Fig. B-5. Quarry tile installed on floor that will withstand heavy pedestrian traffic

finish, which can be either a clear or colored glaze. Usually, they are vitreous or semivitreous.

The most widely used of these tiles are the porcelains, which have a smooth, hard finish, and the natural clays, which have a finish that is less smooth and hard than that on the porcelains. Both of these tiles are vitreous.

Paver Tile

Paver tiles usually are made by the dust-press method. They have a facial area of 6 by 6 inches (15.2 by 15.2 centimetres) or more and a thickness of ⅜ to ⅝ inch (1.0 to 1.6 centimetres). Otherwise, paver tiles resemble ceramic mosaic tiles in appearance. Paver tiles are very durable and are used where long service is desired. They also are available with nonskid surfaces.

Minor Types of Tile

Many other types of tile can be used to produce special effects.

Glass Mosaic Tile

Glass mosaic tiles, which are available in a complete range of colors, are used for a variety of purposes, ranging from building exteriors (Fig. B-7) to bar and fireplace facings and from column shapes to table tops. Most of the glass mosaic tiles used today are imported from Italy, but some are shipped from Spain, Mexico, and Japan. Glass mosaic tiles are made by a process in which the molten glass is poured into waffle-type molds from which the cooled glass is broken into individual tiles and mosaics. These products generally are mounted on paper similar to that used for ceramic mosaic tiles. The sheet sizes usually are 12 by 12 inches (30.5 by 30.5 centimetres), and the paper is on the face side of the tiles. The tiles are about 3/16 inch (0.5 centimetre) thick.

An older type of glass mosaic tile is available in various sizes. It looks like plate glass with a gold leaf sandwiched between the two fused sheets of glass. This tile is called gold venetian glass tile. Its thickness is about ¼ inch (0.6 centimetre).

Glass mosaic tiles usually are mounted on paper in the factory to conform to the needs of the tile job. For example, some sheets are cut along prescribed lines according to the design. The sheets are numbered on the back or paper side with large numbers and on the front side with smaller numbers. The numbers on the front are on paper tabs that are made of masking tape and extend from the top, bottom, or center. A bold red line on the back and on the tab designates a centerline, parallel line, or spring line on the sheet where the tesserae change directions or where the tiles are cut smaller to turn a corner with a small radius. The match marks are penciled on the back. These cut sheets usually conform to a master layout plan prepared in numerical order by a mosaicist, and they carry the notation that the master plan is shown in reverse.

Although foreign manufacturers of glass mosaic tiles indicate dimensions in centimetres and millimetres, in this country these tiles usually are specified in inches. For example, the 2 by 2 centimetre size is approximately ¾ by ¾ inch; the 2.5 by 2.5 centimetre size is 1 by 1 inch; and the 3.0 by 3.0 centimetre size is 1 3/16 by 1 3/16 inches. The popular rectangular glass mosaic tile is 1.5 by 3.0 centimetres or ⅝ by 1 3/16 inches, and the 1.5 by 1.5 centimetre size is acceptable as ⅝ by ⅝ inch.

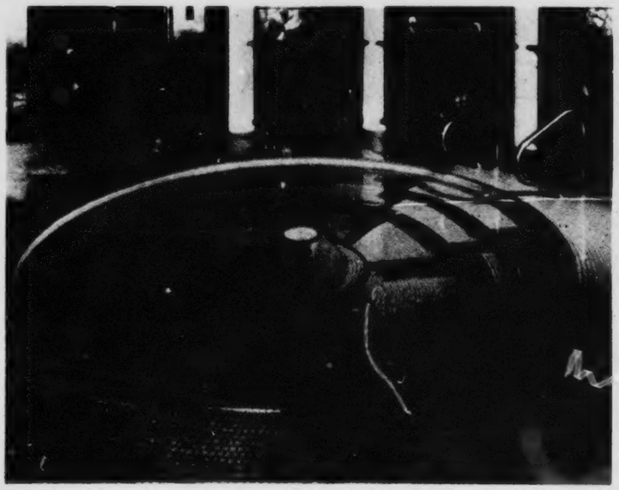


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Fig. B-6. An example of ceramic mosaic installation at Racquetball World, Fountain Valley, Calif.

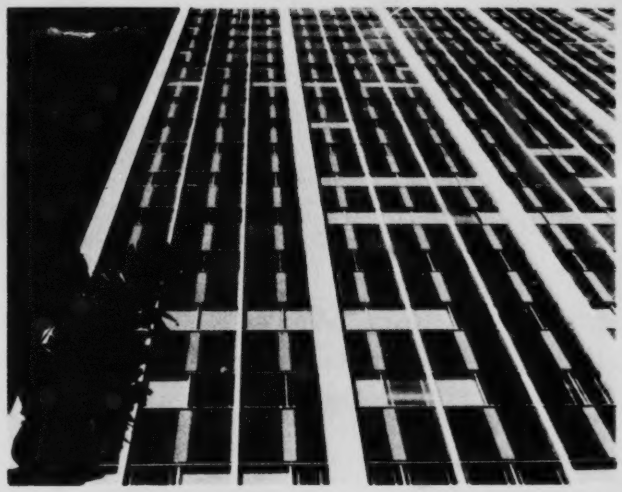

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Fig. B-7. Venetian glass mosaics on the exterior of a building in Los Angeles

Glass mosaic tiles usually are cast with an undercut on the back edge to facilitate setting them around columns and rounded external corners and to make a better key in mortar beds, pure coats, and grout joints. Some are beveled on four sides of the tessera, and these are easier to curve and fit to a column with a small radius or to set as self-edging on outside corners. The setting practices and the type of mortar and grout mixes for these glass mosaic tiles are the same as those for the installation of ceramic mosaic tiles.

Cement Body Tile

Cement body tiles are made from a mix of portland cement and sand or aggregate, with an inorganic coloring material added (Fig. B-8). They are formed by a dry-press or slush-mold process. Because no federal or industrial specifications regulate these tiles, the tilesetter must rely on the reputation of the tile manufacturer to ensure high-quality products. Cement tiles come in plain colors, patterns, and terrazzo designs; however, these colors and designs fade under sunlight. Pebble aggregate tiles with ground face surfaces and exposed aggregate or exposed pebble surfaces are available. These tiles are formed by the addition of organic materials to the face of the product, a process that kills the set of the cement in that area and permits the removal of the cement and fines from the surface to expose the clean aggregate or pebble.

Faience Tile

Faience tiles usually have a glazed surface with a handmade appearance produced by a special treatment of the glaze and the bisque. They are used for special decorative effects (Fig. B-8). The name of the tile comes from the Italian town of Faenza, where a tile resembling fine Persian tile was made in medieval times; hence, the French called this type of tile "faience." These tiles range in size from 6 by 6 inches (15.2 by 15.2 centimetres) to 12 by 12 inches (30.5 by 30.5 centimetres), and they usually are thicker than glazed wall tiles. Unglazed faience tiles also are available.

Smalti-Type Glass Mosaic Tile

Smalti-type glass mosaic tiles, also called Byzantine mosaics, have a rough, irregular surface and vary from ⅛ to ⅜ inch (0.3 to 1.0 centimetre) in thickness. The average size of this type of tile is ⅜ by ⅝ inch (1.0 by 1.6 centimetres). Smalti-type tiles are produced in many colors and are used for murals, geometric designs, letters, and variegated backgrounds (Fig. B-9). They have been used by European muralists for centuries to execute murals such as those found in St. Mark's Cathedral in Venice.

Hand-Cut Marble Mosaic Tile

Another type of mosaic tile is a hand-cut marble mosaic tile that varies in thickness, ranging in depth from ⅛ to ½ inch (0.3 to 1.3 centimetres). It comes in many sizes and is used for backgrounds, designs, and floors.

Study Assignment

1. *Recommended Standard Specifications for Ceramic Tile* (TCA 137.1-1976). Read entire specifications.
2. Examine tile displays from manufacturers.
3. Examine tile catalogs.

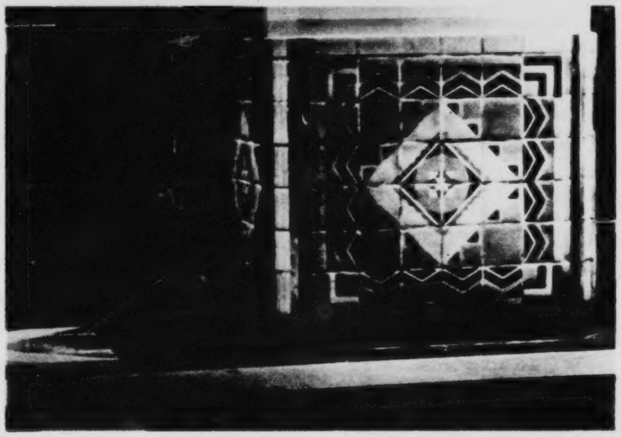

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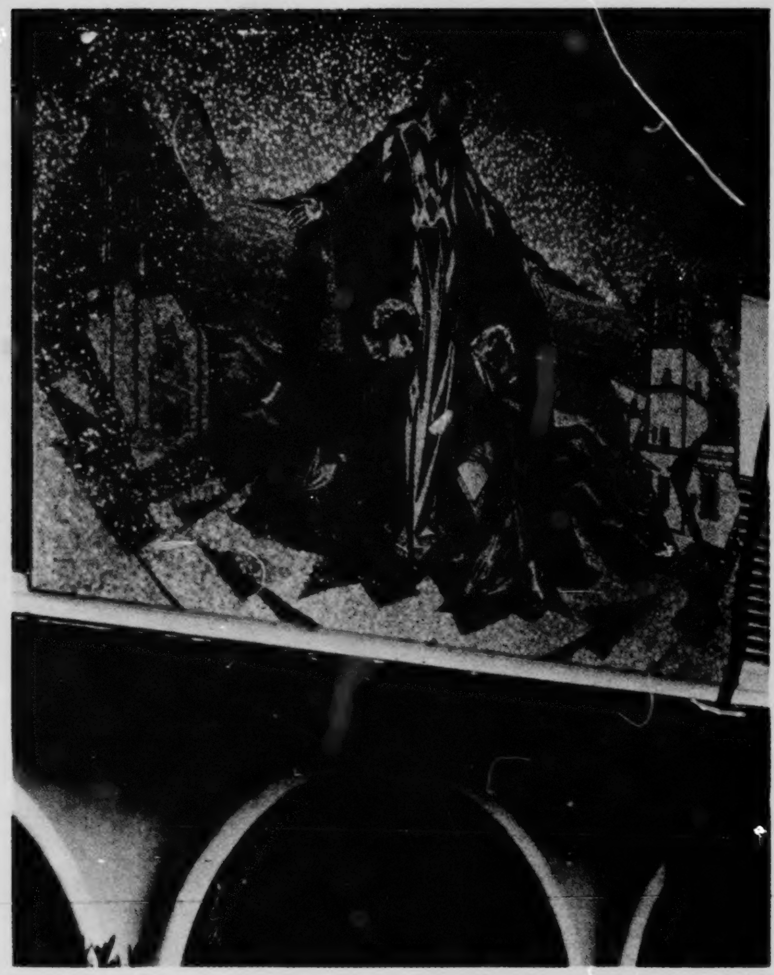
Fig. B-8. Cement body tile on the floor and faience tile around the pillars (Union Train Station in Los Angeles)



See color reproduction on page 123.

Fig. B-9. Smalti-type mosaic on St. Mary Magdalen Catholic Church, Los Angeles

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 2 — TYPES OF TILE

Study Guide

Determine the correct word for each numbered blank in a sentence, and write it in the corresponding blank at the right.

1. The smallest tiles with which the tilesetter works are the paper-mounted 1, which may be as tiny as 2 by 3 inch.
1. ________
2. ________
3. ________

2. For ease in curving them to fit a column of small radius, 4 5 tiles are beveled on four sides of the tessera.
4. ________
5. ________

3. The American equivalent of a foreign-made tile listed as 2 by 2 centimetres is 6 by 7 inch.
6. ________
7. ________

4. The minimum facial area of paver tile is 8 square inches.
8. ________

5. Glass mosaics generally are mounted on paper sheets, with the paper on the 9 side of the tile.
9. ________

6. A(n) 10 coloring material is added to cement tile.
10. ________

7. Smalti-type glass mosaic tiles are also called 11 mosaics.
11. ________

8. The setting practices for glass mosaic tiles are the same as those for 12 13 tiles.
12. ________
13. ________

9. The colors in 14 tile will fade when the tile is exposed to extreme sunlight.
14. ________

10. Faience tile has a 15 appearance.
15. ________

TOPIC 3 — BASE MATERIALS

This topic is planned to provide answers to the following questions:

- **What base materials are used in tilesetting?**
- **How are mortar mixes prepared?**
- **Which type of portland cement is used in setting ceramic tile?**

In this topic the base materials that make up the setting bed are discussed. Tilesetters must use these materials whether they work from the studs or from a more finished backing. Apprentice tilesetters must be familiar with the base materials used in the trade if they are to be able to prepare and set tiles on horizontal and vertical surfaces in an efficient manner. By learning the properties of each material, they will be better able to foresee some of the results of using different types of ingredients in the mix.

Mortar mixes generally serve as the principal base materials for tile installations; however, thin-set portland cement mortars and special adhesives have come into popular usage for particular installations. All types of base materials and caulking compounds are discussed in this topic. Regardless of the kind of base material used, however, tilesetters should always follow the manufacturer's specifications carefully.

Mortar Mixes

Specially processed cements and additives have been developed to meet the particular requirements of a job.

Portland Cement

The basic ingredient in most mortar mixes is portland cement, which is the same material used in concrete.

The name *portland* is not a brand name and is not derived from the name of a city. It was given to the product in 1824 by Joseph Aspdin, an English stonemason, because he thought the concrete made with it resembled the stone quarried from the Isle of Portland in England.

Portland cement is mixed with other ingredients. When water is added to the mixture, a paste is created that will bind the mixture together, thus forming concrete. The paste hardens as it ages, and in time it becomes stronger than the rocks, aggregates, or other materials that have been mixed with it. The portland cement mortar used in setting beds by tilesetters is of the same origin as this concrete, but it does not contain the rocks and other large-sized aggregates found in concrete.

Mortar is mixed in the amounts required for a particular job. The proportions of the ingredients in the different mixes may vary, but the mixing procedures remain the same. Additives may be used to enrich mortar when tilework is installed under conditions that require maximum mortar strength, extreme water resistance, acid or alkali resistance, resiliency, or special adhesive qualities. Hydrated lime may be added if it is needed.

Regular portland cement is normally gray or gray-brown in color. White portland cement is available, at a higher price, if needed for a specific job. It is made by processes that introduce no color into the cement.

Unless the architect specifies otherwise, ceramic tile should be set with Type I (normal) portland cement. High-early-strength portland cement (Type III) is used occasionally.

Manufacturers of portland cement use trade or brand names under which their products are sold. Portland cements are made to meet certain standard specifications.

Five types of portland cement have been described in American Society for Testing Materials (ASTM) Specification C-150. They are the following:

Type I. Type I portland cement is used where high early strength is not required and where the concrete will not be subjected to water with a high sulfate content. It is used for tilesetting and plastering and for structures such as sidewalks, pavements, buildings, bridges, sewers, and culverts.

Type II. Type II portland cement is used in large structures because it generates heat at a lower rate than does normal cement and because it offers greater resistance to sulfate water.

Type III. Type III portland cement is a high-early-strength cement that is ground more finely than normal cement. It is used during periods of cold weather when forms must be removed as soon as possible.

Type IV. Type IV portland cement is a low-heat cement that is used when large volumes of concrete are needed for such structures as big dams.

Type V. Type V portland cement is a sulfate-resistant cement that is used only in structures that will be exposed to severe sulfate action or water with a high alkali content.

All five types of portland cement are not always available. Unless otherwise specified, Type I cement is furnished.

Plastic Cement

Plastic cement is a special mix of Type I portland cement to which resin, rosin, or stearate has been added to make it water resistant. It is widely used in the plaster scratch coat because of this property. Less water is absorbed from the wall mortar, and the water is absorbed more slowly. This results in a better bond between the scratch coat and float coats and a harder, denser mortar. Plastic cement also is used for wall mortar because of its greater plasticity. Less lime is required in the mix, and a better control of the setting time is achieved; however, plastic cement never should be used for pure coat.

Lumnite Cement

Although lumnite is a structural cement, it is not a portland cement. It is made of different raw materials and by a different process. Because of its unique chemical and physical properties, lumnite makes a concrete mortar that can be used for many special purposes and under conditions where ordinary concrete and mortar cannot be used. Lumnite is a quick hardening cement. Mortar and concrete made with it acquire curing strength within 24 hours of mixing.

Aggregates

To prevent the shrinkage of mortar during the drying process, and to make mortar more economical to use, materials known as aggregates are added to the mix. Sand is the aggregate most generally added, although other materials may be used.

Sand, which is graded from fine to coarse, can be obtained by washing and screening sand deposits. It also is collected by grinding rocks or loosely consolidated sandstones. Sand should be kept free of organic or deleterious matter that may produce stains in the joints or affect the setting time of the cement. (See American National Standard Specification A108.)

When it is delivered, mortar sand should be clean and well graded. Care should be taken to keep it that way and not to allow dirt and other contaminants to get into it. River-bed, ocean, or beach sand should never be used, because it is not properly graded, and it contains animal and vegetable matter, salt, and sometimes soap-like elements. These contaminants will cause the mortar to disintegrate. An unwashed sand should never be used for tilework. The sand used should meet the standards of ASTM Specification C-144.

Vermiculite is a lightweight mineral aggregate that is formed when the mineral vermiculite, which is a type of mica, is subjected to high temperatures. The furnace heat expands the plate-like particles in much the same way as an accordion is expanded by drawing apart the leaves of the bellows. The final product weighs only 8 pounds per cubic foot (3.6 kilograms per 0.03 cubic metre).

Some contractors have used vermiculite as a substitute for sand in wall mortars. Its porous and highly absorptive qualities prevent the premature drying out of the mortar bed, thus ensuring that the mortar strength will be adequate.

Perlite is another lightweight cellular aggregate. It is formed from volcanic glass that has been ground to a fine sand and then subjected to high temperatures. This tends to expand the particles by softening them sufficiently to permit the entrapped gases to swell the perlite several times its natural size. This lightweight aggregate has been used successfully by tilesetters in mortar mixes to partially or wholly replace the sand. A low-alkali portland cement should be used with perlite.

Additives

Several types of mortar and grout additives are available for tilework. These should be used only if specified and then only in the amounts specified.

The calcium chloride base additives produce a denser, more water-resistant mortar and also hasten the development of maximum mortar strength. They have a tendency to accelerate the setting of portland cement. When additives are mixed with grout, a much harder grout is produced.

Many polyvinyl acetate additives can be used with portland cement. Each one has a different chemical structure. These additives increase the resiliency of the cement and give a greater bond to the mortar base. When polyvinyl acetate additives are used in the grout, they produce a better bond to the tile and give some flexibility.

The butadiene latex mixes are specially prepared to make them compatible with portland cement. These additives give greater flexure to the mortar, a better bond to the backing, and more plasticity to the mortar. In addition, when combined with the proper mixture of graded sand and portland cement, they produce a very good thin-set mortar. Added to grout in the proper proportions, these materials produce a much more flexible grout that has greater adhesiveness to the tile.

Lime

Lime is a cementing agent that provides a high water retention and plasticity in mortar. The effect of lime crystallization is an increase in the bond strength. It also gives greater flexure and shear to the mortar.

Lime is obtained principally from the burning of limestone. The limestone may be calcium carbonate or magnesium carbonate. Magnesium lime usually has the greater water retention (plasticity).

In previous years most lime used in construction work was in the form of lime putty, but now it is dried and bagged. This hydrated lime is chemically the same as lime putty. Only enough water is added to quicklime during the manufacturing process to satisfy its chemical demand. Subsequently, when water is added, lime putty forms. Hydrated lime should conform to ASTM Specification C-206 or C-207, Type S, which means the lime is hydrated for masonry.

Dry mortar that contains lime has considerable suction when it is brought into contact with wet mortar; therefore, lime usually is not included in scratch coats.

The mortar mix should consist of one part portland cement, one part lime, and five to seven parts sand. Because of the plastic properties of various limes and the different grades of sand, the formula may have to be varied to obtain a working plasticity. The amount of lime should be increased or decreased, but the amount of cement should remain the same.

Water

Water that is suitable for drinking is not necessarily the best for mixing mortar. If it contains sugar or citrates, the water is unsuitable for mixing mortar but could be suitable for drinking. If the water used to mix the mortar is taken directly from a supply that is intended for domestic use, the tilesetter may be reasonably sure that it is satisfactory. However, because water that has been standing in a barrel or other container on the job may have been used to wash equipment, it should not be used for mixing mortar.

Thin-Setting Materials

Many new products are being introduced into the tile industry. Each one is designed to meet a specific need and will do a good job if it is used in the right place and in the right way. Among these new products are the Dry-Set (thin-set) portland cement mortars, organic adhesives, latex-based adhesives, and epoxies.

To avoid costly failures, the tilesetter or contractor should obtain and study all available information about any material before it is used. Particularly important for the successful use of thin-setting materials is their application over sound backing. Care should be taken in the use of these materials for interior installations in wet areas. Furthermore, many of these materials should not be used for exterior installations or for interior locations that might experience a heat buildup, such as around ovens.

Dry-Set (Thin-Set) Portland Cement Mortar

Thin-set portland cement mortar is a mixture of cement, sand, and additives to impart water retentivity. This mortar is suitable for use over a variety of surfaces. It is used in one layer as thin as $\frac{3}{32}$ inch (0.2 centimetre), after tiles are beaten in. It has excellent water and impact resistance; and it is water cleanable, nonflammable, and good for exterior work. Thin-set mortar requires no presoaking of the tile.

Thin-set portland cement mortar is available as an unsanded mortar and as a factory-sanded mortar. Presanded mortars, to which only water need be added, are strongly recommended. Thin-set portland cement mortar is not affected by prolonged contact with water, but it does not form a water barrier. It is limited in truing or leveling the work of others to a thickness of about ¼ inch (0.6 centimetre).

Complete installation and material specifications are contained in ANSI A108.5-1976 and ANSI A118.1-1976. Specifications for conductive thin-set mortar are contained in ANSI A108.7-1976 and ANSI A118.2-1976.

Latex-Portland Cement Mortar

Latex-portland cement mortar is a mixture of portland cement, sand, and a special latex additive that is used as a bond coat for setting tile.

The uses of latex-portland cement mortar are similar to those of thin-set portland cement mortar. It is less rigid than portland cement mortar. Since latices vary, however, the manufacturer's directions should be followed carefully.

When latex-portland cement mortar is used to install ceramic tile in an area that may not thoroughly dry out in use (e.g., swimming pools and gang showers), the completed installation should be cured for a minimum of 14 days and be allowed to *thoroughly dry out* before being exposed to water. Early exposure inhibits full development of the strength of the latex mortar and increases water sensitivity.

Complete installation and material specifications are contained in ANSI A108.5-1976 and ANSI A118.4-1976.

Organic Adhesive

Organic adhesive is ready to use with no further addition of liquid or powder. This adhesive cures or sets by evaporation.

Adhesives obviate the soaking of tile. They are not generally suitable for swimming pools or exteriors. They supply some flexibility to the tile facing. Bond strength varies greatly among the numerous brands available.

Study Assignment

American National Standard Specification A108.1. New York: Tile Council of America, Inc., 1976. Read entire specification.

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 3 — BASE MATERIALS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The type of cement generally used for setting ceramic tile is Type _1_ _2_ cement. 1. ________ 2. ________

2. The basic ingredient in most mortar mixes is _3_ _4_. 3. ________ 4. ________

3. Plastic cement often is used in scratch coats because of its _5_ _6_. 5. ________ 6. ________

4. Lumnite cements harden in _7_ time than do the portland cements. 7. ________

5. The aggregate most generally used in mortar mixes is _8_. 8. ________

6. The mortar mix additives that tend to accelerate the setting of portland cement are those with a base of _9_ _10_. 9. ________ 10. ________

7. Lime putty is formed from hydrated lime by adding _11_. 11. ________

8. A(n) _12_ _13_ portland cement should be used with perlite. 12. ________ 13. ________

9. High-early-strength portland cement is used especially in _14_ weather. 14. ________

10. Regular portland cement is _15_ in color. 15. ________

TOPIC 4 — BACKINGS

This topic is planned to provide answers to the following questions:

- **What types of backings are used in the tilesetting trade?**
- **How is metal lath installed?**
- **What types of wire mesh are used by the tilesetter?**

A tile installation is only as strong as the base or foundation on which it is set. The cause of most tile failures is the incorrect use of backing materials; therefore, apprentice tilesetters must know the various types of building materials that are acceptable as backing for mortar or thin-set materials. Each type of material has certain limitations. When tilesetters understand these limitations, they will know why a particular horizontal or vertical surface should be prepared in a certain way to receive tile; and, as a result, they will do a better job of tilesetting.

Backing Materials

Many of the materials used in the tilesetting trade also are used in the plastering trade, but they are used differently. For example, the plastering trade recommends the use of a "breather"-type asphalt-saturated paper behind portland cement. The tilesetting trade recommends the use of a vapor barrier or water-repellent paper. Tilesetters have found that if the moisture is held in the cement mortar as long as possible, the mortar bed has a better chance to cure correctly; and less shrinkage, which could cause hairline cracks in the tilework, will occur.

Wire fabric, metal lath, and reinforcing wire should conform to the specifications of the American Society for Testing Materials (ASTM). When such materials meet ASTM standards, they are given the ASTM label.

Tie Wire

Tie wire should be used on vertical surfaces where wood is used or where studs are more than 8 inches (20.3 centimetres) on center. Tie wire is 18-gauge galvanized steel wire woven 6 to 8 inches (15.2 to 20.3 centimetres) apart in a parallel pattern. The lacing of the tie wire between studs ensures a uniform thickness in the scratch coat and gives a support to the waterproofing paper that will be applied under the metal lath.

Waterproof Cleavage Membrane

Asphalt building paper or plastic sheeting should be used directly over studding (after tie wire is applied) or over any solid backing that requires waterproofing. Such material prevents the mortar bed from drying out too fast, thus allowing it to cure and to form a strong bond with the tile. The membrane isolates the tile installation from any movement of the structure. The scratch coat and setting bed can be applied more uniformly when building paper is used.

Several types of waterproof material have been accepted in the trade. These include 15-pound (7-kilogram) asphalt-saturated waterproof building felt, 13-pound (6-kilogram) coal-tar-saturated waterproof building felt, duplex reinforced asphalt paper, and polythylene sheeting of at least 0.004 inch (0.01 centimetre) nominal thickness. The 15-pound (7-kilogram) felt paper is the most widely used. A roll of felt paper contains 324 square feet (30.1 square metres), of which 24 square feet (2.2 square metres) is taken up in the overlap.

In accordance with ANSI Specification A108.1, all tilework must be backed with waterproof building paper or felt that meets the standards of Federal Specification UU-P536. Each sheet of material should be free from holes or breaks and should overlap the next sheet a minimum of 2 inches (5.1 centimetres).

Paper-Backed Wire

Paper-backed wire is not recommended as a backing for ceramic tile. This type of wire has the following disadvantages:

1. The exposed edges of wire are not wide enough to allow for a full mesh wire-to-wire lap. This lap is required by Ceramic Tile Institute standards, tile industry standards, and building codes. The lap is necessary to prevent cracks in tile walls.
2. When the paper-backed wire must be cut to fit the wall, the paper and wire both terminate at the same line. When the cut pieces are lapped, the paper completely separates the two thicknesses of wire, and the necessary wire-to-wire reinforcing is lacking.

Metal Lath

Metal lath is a reinforcing material that provides a grip for mortar when tiles are to be set on wood surfaces. It usually is not required when tiles are set on concrete or brick surfaces.

To prevent rust from forming and rust stains from bleeding to the surface of the tilework, the lath should be rust inhibiting (coated with rust-inhibiting paint), copper bearing (containing a small amount of copper), or galvanized (made from galvanized sheets).

In accordance with ANSI Standard Specification A108-1, metal lath must conform to SPR R3-57 and Federal Specification QQ-B-101c. The lath should be the flat expanded type either painted or galvanized, and it should weigh not less than 2.5 pounds per square yard (1.1 kilograms per 0.8 square metre). Another type of lath that can be used is a welded wire self-furring type consisting of tile-reinforcing mesh that is 2 by 2 inches (5.1 by 5.1 centimetres) and 14/14 galvanized. The following types of expanded metal lath are available:

Type	*Weight per square yard (0.8 square metre), lb. (kg)*
Diamond mesh	2.5 (1.1)
Diamond mesh	3.4 (1.5)
Flat rib	2.8 (1.3)
Flat rib	3.4 (1.5)
⅜ in. (1 cm) rib	3.4 (1.5)
⅜ in. (1 cm) rib	4.0 (1.8)
Sheet lath	4.5 (2)

The Ceramic Tile Institute Technical and Job Problem Committee has inspected a number of jobs where the walls have cracked. Many of these installations were backed with the paper-backed wire. When the tile and mortar were removed, the crack was determined to be over the unreinforced joints in the paper-backed wire.

The American National Standards Institute (ANSI) tile standards for waterproof paper and wire reinforcement for the backing of ceramic tile walls should be followed. Materials that should not be used for tile backing are flat rib metal lath and ⅜-inch (1-centimetre) rib lath. When tile and mortar were removed from cracked tile walls, it was determined that the crack followed the indentation made in the mortar by the rib.

Fasteners

Nails are the most generally used fasteners for attaching metal lath, wire fabric, and wire to wood surfaces. (See the *Introduction to Apprenticeship* for a detailed description of the types of nails and other fasteners.) The common 4d or 6d box nails usually are driven three-quarters of their length into the studs. Once they are driven in at an angle, the nails can be bent to secure the metal lath. Blueheads or lathing nails also are used as fasteners for metal lath.

The lath should not be fastened too securely to wood studding. The tilesetter should allow for expansion or contraction of the building materials.

Staples can be used to fasten self-furring lath to a wood surface. Either a staple gun or staple hammer may be used. The staple should be of a large enough size to penetrate the wood studs adequately and to hold the wire securely.

Patented fasteners are used to attach metal lath to steel. They are driven into prepared holes in the steel and then expanded to fasten the lath to the steel. Tie wire can be looped around the metal lath and through the holes in the steel. The ends of the tie wire then can be secured by twisting.

Self-drilling or self-tapping "Bugle Head" or "Pan Head" screws are used to attach metal or wire lath to steel studs. Wire ties or metal clips also can be used to make attachments. Screw attachment of the collateral materials results in construction without holes or perforations in the weatherproof protective membrane. This is desirable where waterproofing is essential. Because of the rising cost and diminishing quality of construction grade wood framing, steel studs are being used more frequently in all kinds of walls and partitions. Steel stud framing is stable and never changes its size, shape, or dimension after installation.

Shrinkage Mesh

Shrinkage mesh is a reinforcing material that is suitable for use in mortar beds for the installation of tile on floors, drainboard decks, counter tops, and shower receptors. The following types of mesh are available:

1. The 2 by 2 inch (5.1 by 5.1 centimetre) welded wire fabric of 16/16 gauge (weighing 13 pounds per 100 square feet) (or 6 kilograms per 9 square metres)
2. The 3 by 3 inch (7.6 by 7.6 centimetre) welded wire fabric of 13/13 gauge (weighing 19 pounds per 100 square feet) (or 9 kilograms per 9 square metres)
3. The 1½ by 2 inch (3.8 by 5.1 centimetre) welded wire fabric of 16/13 gauge (weighing 17½ pounds per 100 square feet) (or 8 kilograms per 9 square metres)
4. Either the first or the third of the above, in the self-furring type

All of these wire fabric meshes are usable for drainboard work. They are manufactured in a number of different widths to fit standard or wide drainboards. Only a minimum of material has to be trimmed off.

The reinforcing metal must be applied with a lap of one full mesh to ensure wire-to-wire contact. The reinforcing wire should be positioned in the approximate center of the mortar bed by the use of spots of mortar. These spots of mortar are positioned before the reinforcing wire is laid out. Foreign objects should not be used to hold the wire in the center of the mortar-setting bed. The reinforcing wire should be kept 1 to 2 inches (2.5 to 5.1 centimetres) from any vertical surface.

Both the 2 by 2 inch (5.1 by 5.1 centimetre) and the 1½ by 2 inch (3.8 by 5.1 centimetre) wire meshes have been used successfully for wall work in place of metal lath. Furring nails ought to be used over both wood studs and solid backing; otherwise, the self-furring type mesh should be used.

Study Assignment

American National Standard Specification A-108. Read specifications for metal lath, waterproof cleavage membrane, and building paper.

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UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 4 — BACKINGS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The _1_ -pound asphalt-saturated waterproof building felt is a suitable vapor barrier. 1. ________

2. When waterproofing is required, _2_ building paper or plastic sheeting should be used. 2. ________

3. The shrinkage of mortar may cause _3_ cracks in the tilework. 3. ________

4. If water is held in the mortar as long as possible, the mortar bed has a better chance to _4_ properly. 4. ________

5. The tilesetter should use _5_ -repellent paper as a backing for tilework. 5. ________

6. The reinforcing wire should be placed in the approximate _6_ of the mortar bed. 6. ________

7. Reinforcing wire floors must be _7_ one full mesh. 7. ________

8. Welded wire fabric measuring _8_ inches in a 16/16 gauge may be used as a reinforcing material for counter tops. 8. ________

9. A staple gun can be used to fasten lath to _9_ surfaces. 9. ________

10. Sheets of waterproof building paper should overlap at least _10_ inches. 10. ________

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 5 — LAYOUT AND LEVELING TOOLS

This topic is planned to provide answers to the following questions:

- **What tools are used to lay out tilework?**
- **How is the steel square used?**
- **How are leveling tools used?**

Although a number of tools required by the tilesetter already have been discussed in the *Introduction to Apprenticeship*, their uses in setting tile often are specialized. In this topic the discussion is limited to the tools used by tilesetters in laying out their work and in ensuring that it is level.

Layout Tools

The most frequently used layout tools are the chalk line, measuring tape, story pole, and framing square.

Lines

The chalk line, such as the one discussed in the *Introduction to Apprenticeship*, has a variety of uses. The tilesetter uses it for laying down working lines, finish lines, plumb lines, and level lines. The metal case for enclosing the line will hold an ample supply of chalk and will keep the line clean.

The mason's line or plain line is useful in lining up the faces of the floating rods on long walls or floors. It also is used in setting lines in the layout of designs and quarry tile. The preferred cord for a mason's line is made of nylon.

Measuring Tape

The tilesetter will find that the measuring tape is also an invaluable help in squaring and paralleling (Fig. B-10). The steel tape is preferred.

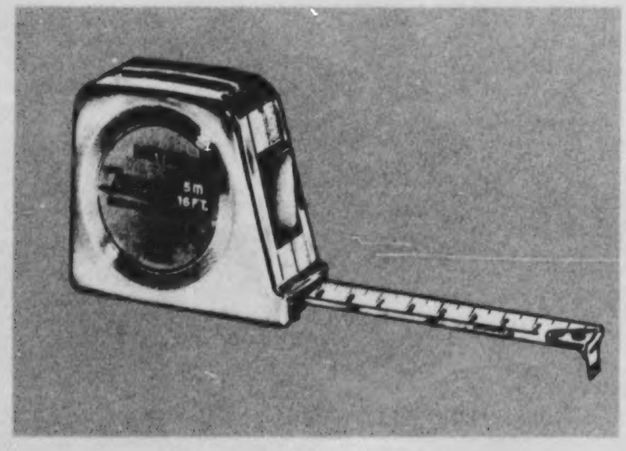


Fig. B-10. Measuring tape

Steel Square

The steel square is one of the most important tilesetting tools (Fig. B-11). The large arm of the square is 2 inches (5.1 centimetres) wide and 24 inches (61 centimetres) long and is called the body or blade. The smaller arm is at a 90-degree angle to the blade and is 1½ inches (3.8 centimetres) wide and 16 inches (40.6 centimetres) long; it is called the tongue. The point where the outside edges of the blade and tongue join is called the heel. The surface with the manufacturer's name is called the face; the opposite surface is called the back.

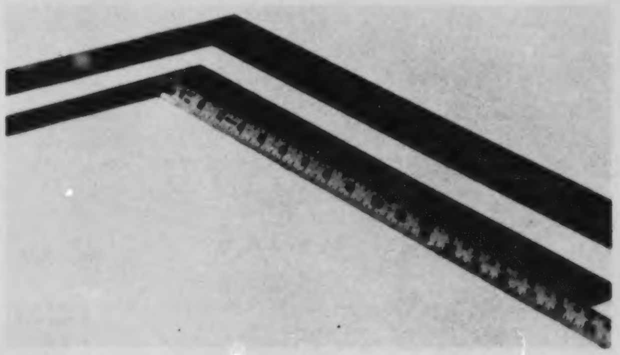


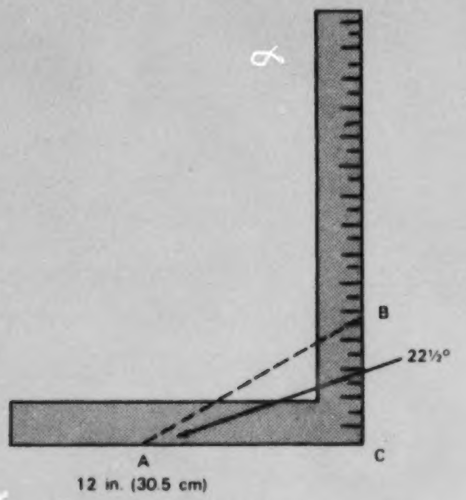
Fig. B-11. Steel square

The tilesetter can use a steel square to lay out any angle shown in the following table:

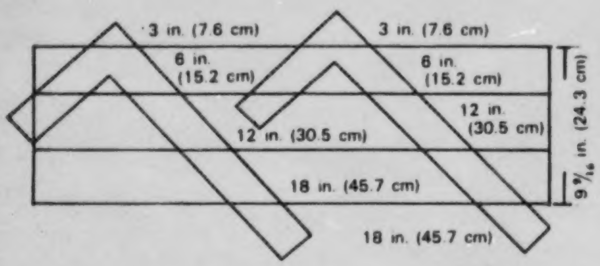
Angle, degrees	*Distance, inches*	*(centimetres)*
5	$1\frac{1}{16}$	(2.7)
10	$2\frac{3}{32}$	(5.3)
15	$3\frac{7}{32}$	(8.2)
20	$4\frac{3}{8}$	(11.1)
22½	$4\frac{31}{32}$	(12.7)
25	$5\frac{19}{32}$	(14.2)
30	$6\frac{15}{16}$	(17.6)
35	$8\frac{13}{32}$	(21.4)
40	$10\frac{1}{16}$	(25.6)
45	12	(30.5)
50	$14\frac{5}{16}$	(36.3)
55	$17\frac{1}{8}$	(43.5)
60	$20\frac{25}{32}$	(52.8)

To draw any angle, the tilesetter should place a point at the 12-inch (30.5-centimetre) mark on the tongue and another point at the distance in inches on the blade as shown in the table for the desired angle.

In the following illustration, point A is marked at 12 inches (30.5 centimetres) on the tongue, and point B is marked at $4\frac{31}{32}$ inches (12.7 centimetres) on the blade. Angle BAC is 22½ degrees.

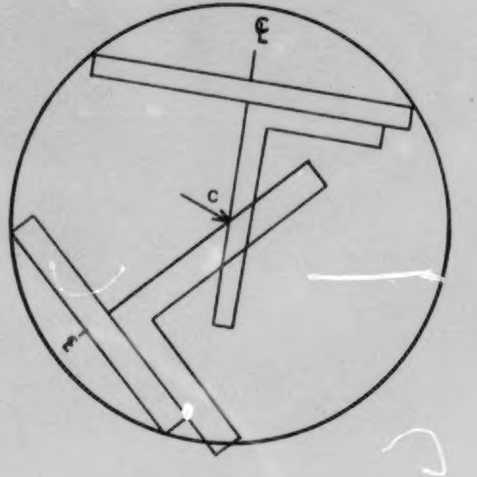


Dividing a space between two lines. To divide a space between two parallel lines with measurement in inches and fractions of an inch into the required equal spaces, lay the blade of the square diagonally across the space to an easily divisible number, so that the distance will divide evenly on the inch marks into the desired number of spaces; then, shift the square to second position, and connect the lines. (See following illustration.)



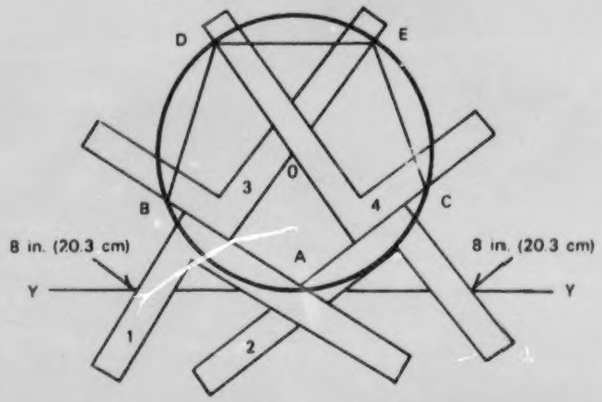
Finding the center of a circle. The steel square and straightedge can be used to find the center of a circle. (See the accompanying illustration.) The procedure is as follows:

1. Place the heel of the square on the exact center of the straightedge.
2. Draw a sharp line along the blade.
3. Shift the straightedge to another position as shown in the drawing.
4. Repeat steps 1 and 2. The center of the circle will be where the two lines intersect.



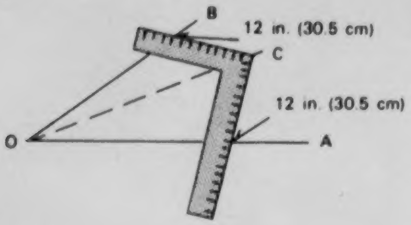
Drawing a pentagon. A pentagon can be constructed as follows (see following illustration):

1. Draw line YY as shown in the illustration.
2. Apply the square with the 8-inch (20.3-centimetre) mark on the tongue and the 11-inch (27.9-centimetre) mark on the blade in alignment with YY.
3. Draw AB and AC each as long as one side of the proposed pentagon.
4. Find the centers of AB and AC, and apply the square, bringing the heel to the center points as shown by squares 3 and 4. These squares intersect at 0, which is the center of the circle within which the laying out of the pentagon can be completed. Where this circle crosses the outside edges of the blades of squares 3 and 4 are the two remaining points of the pentagon.
5. Draw lines BD, DE, and EC to complete the pentagon.



Bisecting an angle. A steel square can be used to bisect an angle as shown in the accompanying illustration. The procedure is as follows:

1. Lay square so that the same number is on the tongue and blade at the points where they cross OA and OB.
2. Draw line OC through the heel of the square. Line OC bisects angle AOB.



Angle Divider

The angle divider is used by the tilesetter to determine the degree of an angle to cut (Fig. B-12). It is used for fitting trim, moldings, and floors into corners. A corner angle is measured by adjusting the divider to fit the corner.

T-Bevel

The T-bevel is used to lay out angles up to 180 degrees (Fig. B-13). When the blade has been set to the desired angle, it is secured with a locking device on the handle. The blade does not have graduations indicated, and a protractor is needed for setting the blade unless the T-bevel is being used merely to transfer an angle from one piece of work to another.

Compass Scribe

The compass scribe, which is also called a wing divider, can be used for fitting to an irregular surface, such as a brick wall, stone wall, or wood molding. The tilesetter can use this tool to transfer the irregular shape of the surface to the tile that is to fit against it.

Dividers

When dividers are set to a given dimension, a given number of spaces can be stepped off without laying out the tile. In other words, by setting the dividers to the width of the individual tiles, the tilesetter can step off the space to be occupied by each tile.

Combination Square

The combination square is a small square with an adjustable head and a blade that is usually 1 by 12 inches (2.5 by 30.5 centimetres). It is used on jobs where a large square is not suitable (Fig. B-14).

Trammel Bar

A trammel bar, which is easy to construct, is more accurate than many other layout tools (Fig. B-15). It is used to erect perpendicular lines and to bisect angles. The tilesetter can make a trammel bar from a stick of a size that is suitable for the particular job. A notch is cut at one end, and a line is drawn down the center of the bar. From the point of the notch, a measurement should be made along the centerline the distance of the desired radius. At this point, which is used as the center, a nail should be driven. A pencil is secured in the notch.

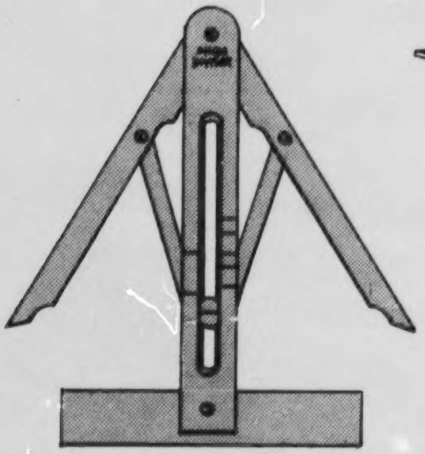


Fig. B-12. Angle divider

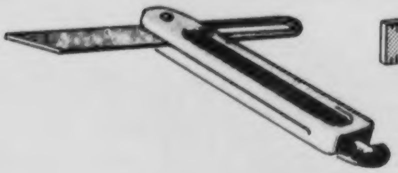


Fig. B-13. T-bevel

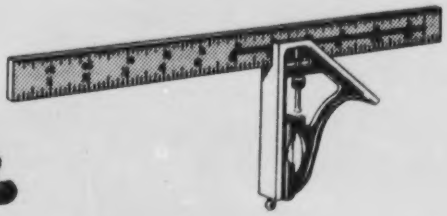


Fig. B-14. Combination square

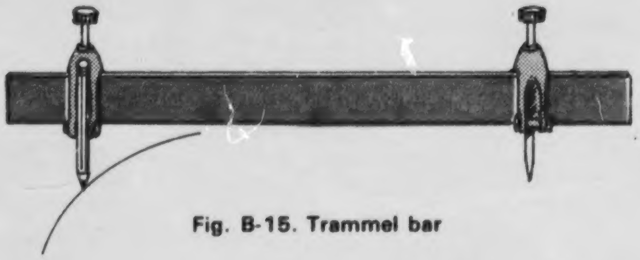


Fig. B-15. Trammel bar

Story Pole

The story pole is used to measure an area in tile unit sizes to determine the size of cuts so as to install tile to give the most pleasing appearance. It is also an important help in stairway construction. More information on the story pole is presented in Unit E, Topic 15. The use of a story pole is demonstrated in Fig. B-16.

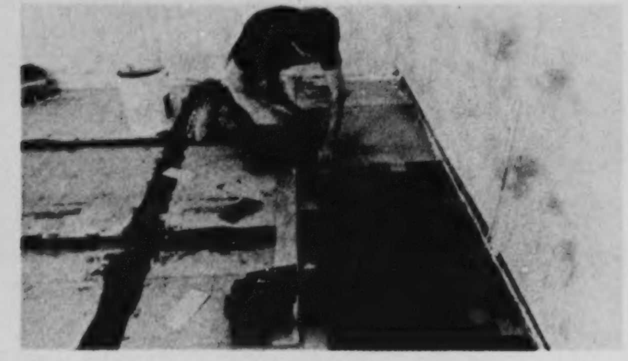


Fig. B-16. Tilesetter using a story pole

Leveling Tools

The tilesetter must learn how to use leveling tools accurately.

Spirit Level

The spirit level is used by the tilesetter for small or close work and wall and floor work (Fig. B-17). When it is used with the straightedge, it can serve to level or plumb certain surfaces or work, such as the floating strips on walls and floors and the screed strips on horizontal surfaces. The 12, 24, and 48 inch (30, 60, and 120 centimetre) spirit levels are generally the most useful for the tilesetter.

Caution should be exercised in purchasing a spirit level, because not all levels are accurate. When a level is being tested for accuracy, it should be placed against a surface that is known to be plumb or level. Each bubble should be checked, and the level should be reversed to see if the bubbles are centered. Because aluminum occasionally warps in manufacture, the sides of the level should be checked to ensure that they are true.

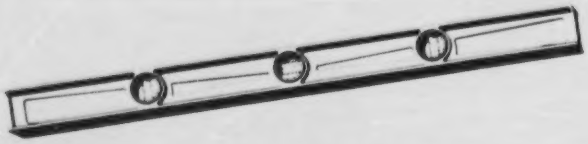


Fig. B-17. Spirit level

Water Level

The water level is a piece of clear plastic hose ⅜ to ½ inch (1 to 1.3 centimetres) in diameter and usually about 50 feet (15 metres) in length (Fig. B-18). It is filled with water, from which all air must be removed. Air bubbles in the hose compress when the level is used. This may cause a false reading. The best way to remove the air is to siphon the water into the hose, letting it run until no more bubbles are seen at the lower end of the siphon. Foreign particles also should be removed.

The water level may be checked to see if it is true by placing the two ends together. If the level is true, the top of the water will be at the same level on both ends. If the level is not the same, an air bubble is in the hose. The bubble can be removed by siphoning through again.

As the water level is moved from mark to mark, the ends of the hose should be plugged with the fingers to ensure that no loss of water occurs. When marks are being established, then and only then are the ends of the hose left open.

The top of the water in the hose has a slightly concave shape. The reading may be taken either from the high point or from the low point, although the reading from the high point is far more easily seen. When two tilesetters are using the water level and moving from mark to mark, they should be sure they are both taking the reading from either the high point or the low point. Because a difference of about ⅛ inch (0.3 centimetre) exists between the two points, the reading would be inaccurate if the high point were used by one tilesetter and the low point by the other.

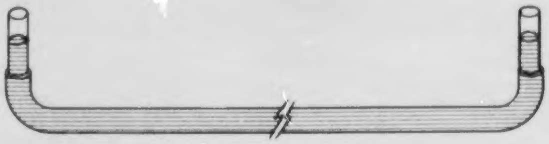


Fig. B-18. Water level

Particular caution should be used in handling the water level outdoors. If one end of the water level is under the hot sun and the other is in the shade, the water in the hot end will expand and rise to cause an error in reading of up to ½ inch (1.3 centimetres). To avoid this, the hose should not be left partly in the sun and partly in the shade for any length of time. If points must be marked, they should be marked quickly, before the water has a chance to heat unevenly. If any doubt exists, the water level should be checked both during and after use.

As a rule, the general contractor uses the builder's transit to furnish grade marks throughout the job for the various crafts. Tilesetters should establish their first water level mark from the grade mark.

One-Person Water Level

The one-person water level is accurate if it is operated correctly. It consists of a container (preferably clear) to act as a reservoir for the water and clear plastic tubing or a water hose with a 6-inch (15-centimetre) glass tube inserted in one end.

Manufactured water levels that can be operated by one person are available, but one can be made inexpensively and with little effort (Fig. B-19). The procedure for filling and using the one-person water level is as follows:

1. Secure one end of the hose near the bottom of the container so that it will not move while you are working with the level around the walls.
2. Fill the container with water.
3. Syphon water out the other end of the hose, which must be lower than the reservoir. When all air bubbles are gone, plug the hose or glass tube, and raise it to the level of the reservoir. The level is now ready to use.
4. Establish bench mark A on the wall. This mark is level with water at B in the container. Make mark on plastic hose or tube with masking tape.
5. Bench mark A can be transferred around the room. Be sure a finger is held over the open end of the hose when you are moving it from one mark to another. If water is lost from the hose, the procedure will have to be repeated, and a new level mark will have to be established at the reservoir. A previously established grade mark can be used if the water in the container is adjusted to that mark.

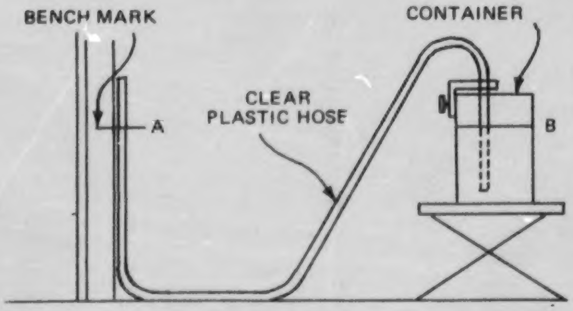


Fig. B-19. Adapted one-person water level

Straightedge

The straightedge is made of lightweight wood, usually ⅞ by 4 inches (2 by 10 centimetres) (Fig. B-20). Its length varies from 2 to 10 feet (0.6 to 3 metres). It is used with the spirit level to plumb and level float strips and also to float and straighten mortar beds. It may be used as a story pole, in which case the tile sizes and their spacings are marked on the straightedge.

Featheredge

The featheredge is made of wood, aluminum, or magnesium (Fig. B-21). It is used to straighten mortar beds. This lightweight straightedge is manufactured in a variety of lengths and shapes.

Plumb Bob

The plumb bob is an accurate tool for indicating a vertical direction (Fig. B-22). A chalk line is tied to the hole in the center of the cap on the bob and then fastened at the ceiling height so that the plumb bob extends to the floor level but does not touch it. A reading is then made with a rule parallel to the string.

Fig. B-20. Leveling with a straightedge

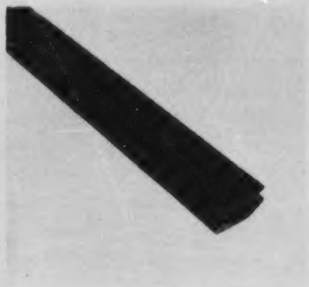


Fig. B-21. Magnesium alloy featheredge

Fig. B-22. Plumb bob

TOPIC 5 — LAYOUT AND LEVELING TOOLS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The _1_ _2_ is used in place of the framing square for small jobs. 1. ________ 2. ________

2. To determine the degree of angle to cut tile trim that is to be fitted into a corner, a(n) _3_ _4_ is used. 3. ________ 4. ________

3. The preferred cord for a mason's line is made of _5_. 5. ________

4. The plumb bob is an accurate tool for indicating a(n) _6_ direction. 6. ________

5. If air bubbles are left in a water level hose, they may give a(n) _7_ reading. 7. ________

6. Water level readings may be taken from either the high point or low point, but generally the most satisfactory are those that are taken from the _8_ point. 8. ________

7. The tilesetter establishes the first water level mark from the _9_ marks furnished by the general contractor. 9. ________

8. The _10_ _11_ can be used for fitting to an irregular surface. 10. ________ 11. ________

9. A straightedge may be used as a _12_ pole. 12. ________

10. Two parts of a steel square are the _13_ and _14_. 13. ________ 14. ________

11. The _15_ is the smaller arm of the steel square. 15. ________

12. The length of the blade of a steel square is _16_. 16. ________

13. The _17_ of the steel square has the manufacturer's name inscribed. 17. ________

14. The open end of the water level must be _[illegible]_ while the level is being moved from one level mark to another. 18. ________

15. A new _19_ _20_ must be established at the reservoir if water is lost from the hose of a one-person water level. 19. ________ 20. ________

TOPIC 6 — CUTTING AND DRILLING TOOLS

This topic is planned to provide answers to the following questions:

- **What cutting tools are used in setting tiles?**
- **What drilling tools are used by tilesetters?**

Good tilesetters are recognized not only by their high-quality work but also by the good condition in which they keep their tools. To perform the best quality work, tilesetters should exercise good judgment in purchasing tools. They should accept only tools of the highest quality, and they should have a sufficient number of them to do the tilework at hand.

Cutting Tools

Various kinds of cutting tools are used in the trade.

Tile Cutter

The tile cutter is one of the most efficient and economical tools in the tilesetting trade (Fig. B-23). A popular model is the hand-drawn tile cutting board that is adjustable. It has a hardened steel scoring wheel (similar to that used to score glass) or a tungsten-carbide-tipped scoring wheel. The wheel moves back and forth as the cut is made on the tile. The breaking bar, which is fitted above a rib in the center of the cutter, is used to exert pressure over the rib to break the scored tile. Different sizes are available for cutting sheets of ceramic mosaic or ceramic veneer tiles (Figs. B-24 through B-26).

Chipping Hammer

The chipping hammer is a lightweight hammer that comes in a variety of sizes (Fig. B-27). The head and back can be capped with tungsten carbide for durability. It is used by the tilesetter to chip excess material from the backs and edges of wall and quarry tiles, thus reducing the amount of grinding work necessary to smooth a cut.

Handsaw

The handsaw is used to cut float strips and straightedges to desired lengths (Fig. B-28). It also is used to cut gauges for floating mortar. A crosscut saw with eight teeth to the inch will prove to be the handiest for the tilesetter. A piece of slotted wood placed over the

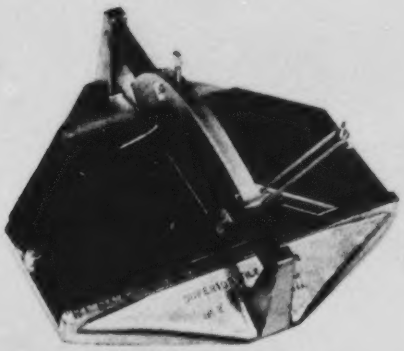


Fig. B-23. Tile cutting board

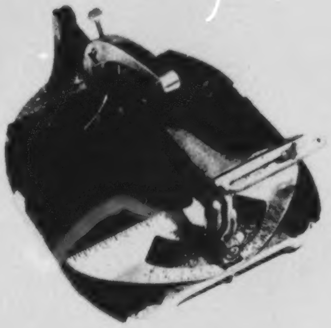


Fig. B-25. All-angle tile cutter

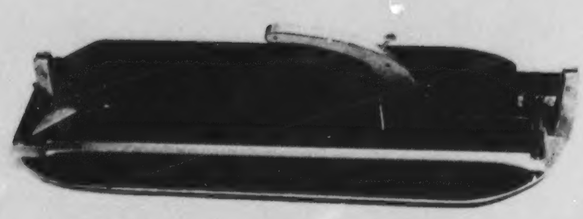


Fig. B-24. Tile cutter for ceramic mosaic and large thin tiles

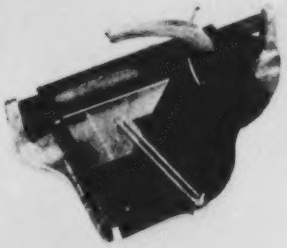


Fig. B-26. Tile cutter for tiles up to 16 inches (40.6 centimetres) in width teeth protects the cutting edge from damage when it is carried in the toolbox. Occasional application of a light oil or paraffin protects the blade from rust. When the blade is lubricated, the saw is easier to use, and it will be more accurate.

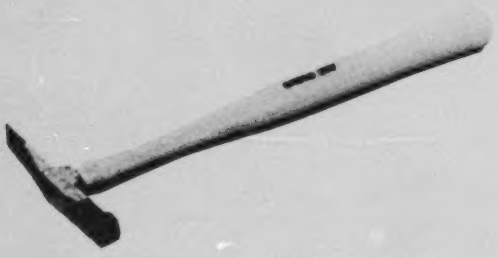


Fig. B-27. Chipping hammer

Fig. B-28. Handsaw

Grout Saw

The grout saw is a saw-toothed carbide steel blade mounted on a wooden handle (Fig. B-29). It is used to remove old grout. It also is used in patching work. Care should be used as it can easily damage adjacent tiles. The carbide steel blade is brittle, and it will shatter if it is dropped or abused. On the front of the saw blade is a spring steel tip. This is used for scraping grout out of corners where the saw blade cannot reach.

Hacksaw

The hacksaw is used to cut metal towel bars to the desired lengths and to remove any metal that interferes with the correct installation of tile. The handle should be so constructed that it protects the user's hand from possible shattering of the blade.

Fig. B-29. Grout saw

Rod Saw

The rod saw is one of the newest tools used in the cutting of tile (Fig. B-30). It is a steel rod approximately ⅛ inch (0.3 centimetre) in diameter. The rod has tungsten carbide particles embedded in the surface. Any regular hacksaw frame can be used to hold the rod. The rod saw is used to cut circles or irregular curves in tile.

Chisel

The chisel commonly used by tilesetters is a patching chisel that is ¼ to ½ inch (0.6 to 1.3 centimetres) in diameter and 6 inches (15.2 centimetres) in length (Fig. B-31). It is used to chip dried mortar, cut quarry tile, cut certain vitreous caps, and break scored tile. The tip is made of tungsten carbide for durability. Chisels should always be kept sharp, and the end that is hammered on should be kept free of burrs. When a chisel has burrs, chips of steel can break off and injure someone.

Nippers

Two sizes of nippers or biters are preferred by the tilesetter (Fig. B-32). The 8-inch (20.3-centimetre) nippers are used for inside curves, and the 10-inch (25.4-centimetre) nippers are used for straight cuts that cannot be made with the tile cutter. These tools usually are tipped with tungsten carbide.

Ceramic mosaic cutters are a specialized form of nippers with a smaller bite and greater leverage. They are effective when used on hard tile.

Tin Snips

A good pair of tin snips is needed to cut metal lath and reinforcing wire (Fig. B-33). Investing in quality tools is particularly important with tin snips. Cheap snips will warp, bend, and chip. In addition, snips should not be used to cut nails or other items that they are not designed to cut, because doing so will damage even those of the highest quality.

Fig. B-30. Rod saw

Rubbing Stone

Carborundum rubbing stones are used to smooth the rough edges of cut tile (Fig. B-34). They range in size from 60-grit for coarse grinding to 80-grit for fine rubbing. When they are not being used, the stones should be placed in a pail of water rather than left where they might be knocked off and broken.

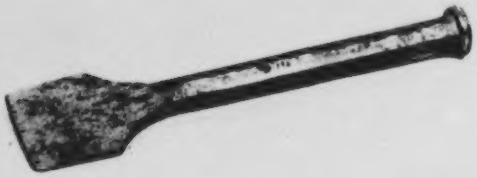


Fig. B-31. Patching chisel

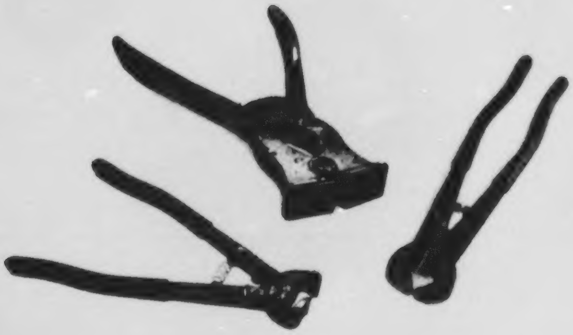


Fig. B-32. Tile nippers or biters

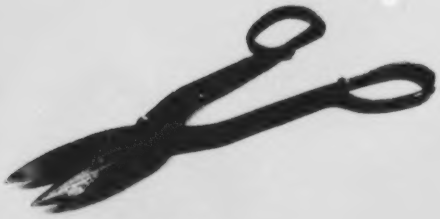


Fig. B-33. Tin snips

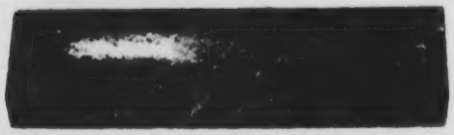


Fig. B-34. Carborundum rubbing stone

Portable Electric Saw

Power tools generally are furnished by the contractor, so the tilesetter does not have to purchase them. However, these tools are expensive and their incorrect use may result in costly repair or replacement. Because they are used so often, the hazards associated with handling them are often overlooked. Every apprentice should seriously study and follow all safety regulations.

The portable electric saw is an important tilesetting tool in repair and remodeling work (Fig. B-35). On quarry floors where joints are to be regrouted, the tilesetter can use the saw equipped with a nylon blade that is impregnated with Carborundum. This saw can be used to remove old grout or sections of cracked tile. A rake line on stairs can be cut with this tool by fastening a straightedge to the wall and moving the nylon blade against this guide to cut a straight line.

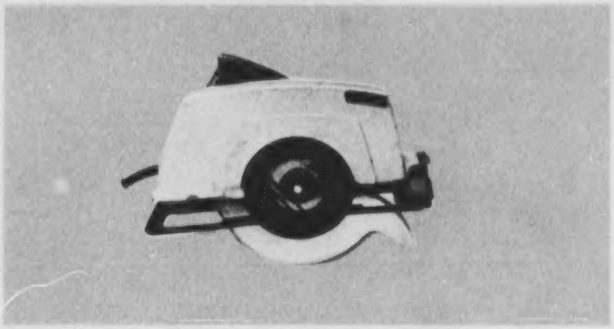


Fig. B-35. Portable electric saw

Electric Table Saw

One of the most useful power tools in the tilesetting trade is the electric table saw (Fig. B-36). Its use ensures accuracy on miters, small liner-type cuts, and vitreous trimmers.

The types of blades that are available include the diamond-bonded steel rim for wet cutting and the Carborundum-impregnated fabric wheel for dry cutting. Diamond blades are made of steel, with the outer rim impregnated with chips of commercial diamond. Coolant water flows upon the wheel as it turns at about 3,000 rpm. This type of cutting wheel is not particularly dangerous, because it has a smooth cutting edge; however, caution should be observed when any power tool is being used.

Blades made of Carborundum break easily and are regarded as unsatisfactory for general use in the tile industry. They are used mostly for cutting bricks and soft patio tile. Goggles and respirators should be worn when dry Carborundum wheels are used.

Care should be taken not to jam tile into the blade. This abuse could cause the wheel to twist or warp, thereby rendering it useless.

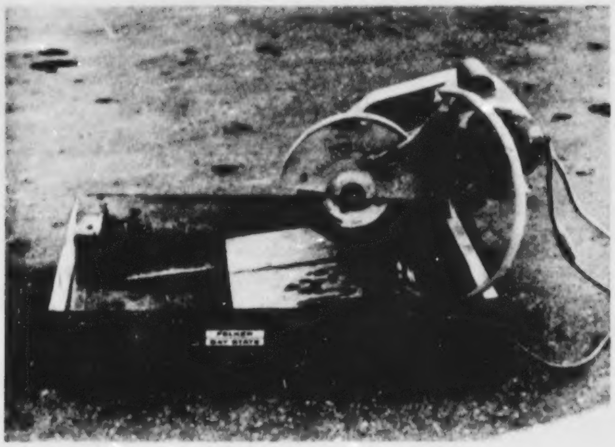


Fig. B-36. Electric table saw

Drilling Tools

The tilesetter will have to learn to use both hand drills and portable electric drills.

Hand Drill

The hand drill is used to drill holes in tile and mortar for installing certain fixtures that are fastened with screws or bolts (Fig. B-37). The drill bits usually are tipped with tungsten carbide to make them more durable.

Portable Electric Drill

The portable electric drill is needed by the tilesetter to hang fixtures and accessories (Fig. B-38). Bits with carbide tips are best for drilling. If they are not available, high-speed bits may be used. The bit is sharpened to the same cutting edge as that of the cold chisel and then ground to a V on two sides, with one point a little longer than the other. A bit sharpened this way can be used on any masonry work.

Drill Bit

When holes are to be drilled through masonry, concrete, tile, or marble, a tungsten carbide masonry drill bit should be used (Fig. B-39). It is used only with electric drills and only at low speeds.

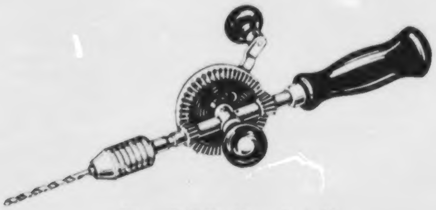


Fig. B-37. Hand drill

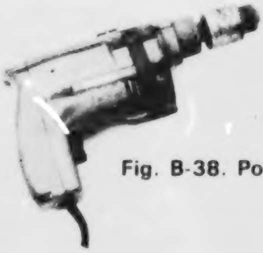


Fig. B-38. Portable electric drill

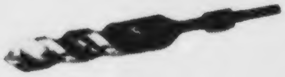


Fig. B-39. Masonry drill bit

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 6 — CUTTING AND DRILLING TOOLS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The most useful handsaw for tilesetters is the 1 with 2 teeth to the inch. 1. ________ 2. ________

2. The tilesetter uses the 3 to cut metal towel bars. 3. ________

3. To chip excess material from the back of wall and quarry tile, the tilesetter uses a(n) 4 5 . 4. ________ 5. ________

4. The most popular wheels for the tile cutter are hardened steel or tungsten- 6 tipped wheels. 6. ________

5. A 7 8 masonry drill should be used to drill through marble. 7. ________ 8. ________

6. Bits with 9 tips are best for drilling. 9. ________

7. The portable electric saw is often used in 10 and 11 work. 10. ________ 11. ________

8. Carborundum blades are used mostly for cutting 12 and soft 13 tile. 12. ________ 13. ________

9. The preferred size for nippers that are to be used for inside curves is the 14 inch size. 14. ________

10. The coolant used with the diamond blade on an electric table saw is 15 . 15. ________

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 7 — MORTAR TOOLS AND OTHER SPECIAL TOOLS

This topic is planned to provide answers to the following questions:

- **What mortar tools are used by the tilesetter?**
- **What special tools are needed in tilesetting?**
- **What care do the tilesetter's tools require?**

The tilesetter's most important tools are the ones used for mixing, handling, and applying mortar, which is the base material used for making tile installations. This topic deals with this group of tools and also with those tools that have a specialized use in the trade (Fig. B-40).

Mortar Tools

Each tool that the tilesetter uses will be discussed individually.

Pointing Trowel

The pointing trowel or pointer is probably the most essential tool in the trade (Fig. B-41). It comes in sizes ranging from 4 to 7 inches (10.2 to 17.8 centimetres) in length, but the 6-inch (15.2-centimetre) trowel is the most popular. The tilesetter uses this trowel in every phase of the work, especially for straightening tiles on walls and floors, marking floated surfaces, filling small depressions on float coats, buttering tiles and trim work, and placing mortar in areas that are too small for the flat trowel.

The butt of the handle is used for tapping in tiles that are not on a true plane with the rest of the tilework.

The trowel's flat working surface must be protected. The tilesetter should not use it to pry or chop hardened materials, such as concrete or plaster.

Fig. B-40. Mortar tools and other special tools

Flat Trowel

The flat trowel is used in conjunction with the hawk for the transferring of mortar from the mortarboard to the wall or to other vertical surfaces (Fig. B-41). It is frequently used for spreading pure cement on the finished float coat. The flat trowel also is used for spreading mortar on floor surfaces before tiles are set.

Buttering Trowel

The blade of the buttering trowel is 4½ inches (11.4 centimetres) wide and 7 inches (17.8 centimetres) long (Fig. B-41). It is used in buttering pure cement to tile, a method commonly used in the eastern states. This trowel is more efficient than the pointer for working on the larger and heavier tiles because more weight can be placed on it.

Brick Trowel

The brick trowel is larger than the buttering trowel (Fig. B-41). The most popular size used by tilesetters is 5 inches (12.7 centimetres) wide and 11 inches (27.9 centimetres) long. It is used when any preparatory brick work has to be done. Some tilesetters use it for quarry and terra cotta tilework. Its greater surface and weight are advantageous in the buttering and tapping in of the larger tiles.

Gauging Trowel

The gauging trowel is larger than the pointing trowel but smaller than the buttering trowel (Fig. B-41). Tilesetters prefer the 3¼ by 7 inch (8.3 by 17.8 centimetre) size.

Rubber Trowel

The rubber trowel used for grouting is a nonporous synthetic-rubber-faced float that is mounted on an aluminum back with a wood handle (Fig. B-42). This trowel is used to force material deep into tile joints and to remove excess material for a perfect finish.

Hawk

Hawks range in size from 10 to 14 inches (25.4 to 35.6 centimetres) square, but tilesetters generally prefer the 11-inch (27.9-centimetre) square (Fig. B-43). Most hawks are made of aluminum, with a wooden handle at the center. A rubber pad fits over the handle and covers that portion of the metal hawk

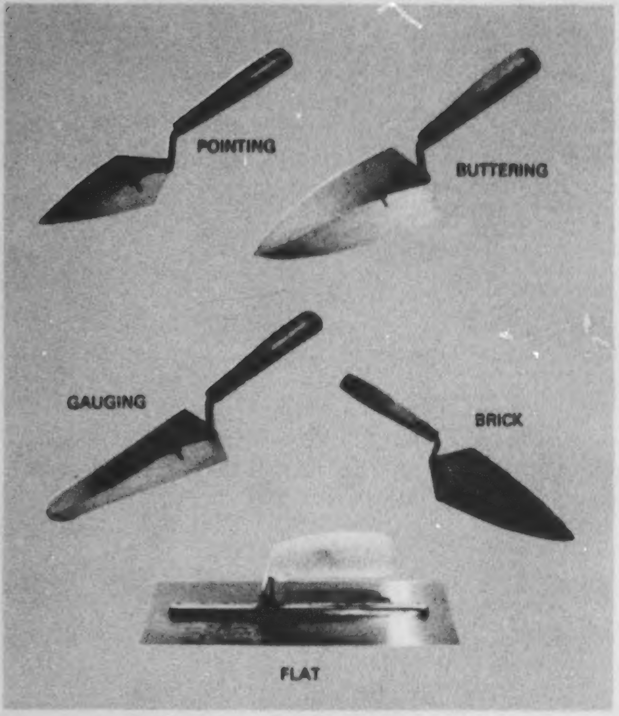


Fig. B-41. Trowels

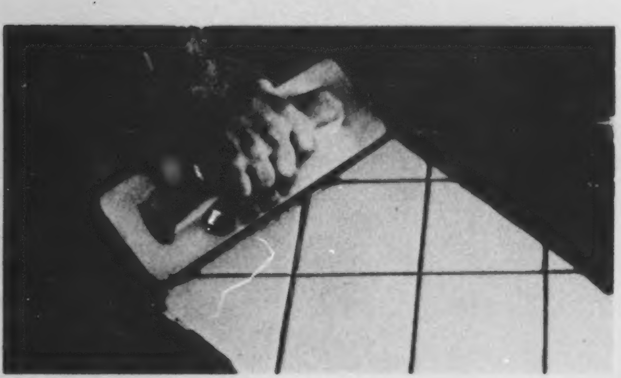


Fig. B-42. Rubber trowel in use

that would come in contact with the hand. The hawk should not be held with a hand that is wet or covered with lime or mortar.

Wood Float

The wood float is sometimes used in place of the flat trowel for floating mortar (Fig. B-44). It is good for smoothing small irregularities left on the mortar bed, working the surface of the mortar before troweling on the pure coat, or compacting floor and deck mortar.

Mortar Hoe

The mortar hoe is used for hand-mixing mortar (Fig. B-45). The best type has a perforated blade and a handle about 5½ feet (1.7 metres) in length. The hoe should be kept clean and free of all mortar so it can be pushed and pulled easily through a box of mortar.

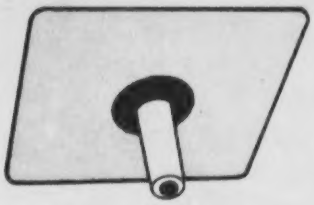


Fig. B-43. Hawk

Fig. B-44. Wood float

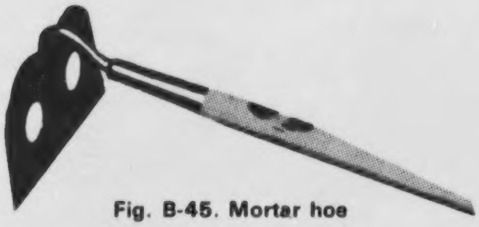


Fig. B-45. Mortar hoe

Mortarboard

The mortarboard is used as a table to hold mortar (Fig. B-46). It is usually 30 inches (76.2 centimetres) square.

Bucket

The bucket used by the tilesetter is generally made of galvanized metal, but it is also available in wood and plastic. The 12-quart (11.4-litre) size is the most practical and is the size referred to in most specifications.

Mortar Mixer

Most mortar mixers are driven by gasoline combustion engines of 1½ horsepower or greater, depending on the type of sack mix (Fig. B-47). Electrically driven mixers are used when small batches of mortar are needed. The quality of machine-mixed mortar far exceeds that of handmixed mortar.

Mortar Pumping Machine

The mortar pumping machine is used with the mortar mixer (Fig. B-48). Mixed mortar is poured into the hopper, and a pneumatic gun forces the mortar through a hose. The mortar can be delivered through the hose to tilesetters working as high as 13 stories above the street. Asbestos fines are added to the mortar as a bonder so that the mortar in the hose will not separate. The plastering gun can be used on the hose, and the hose can be used as a hoist.

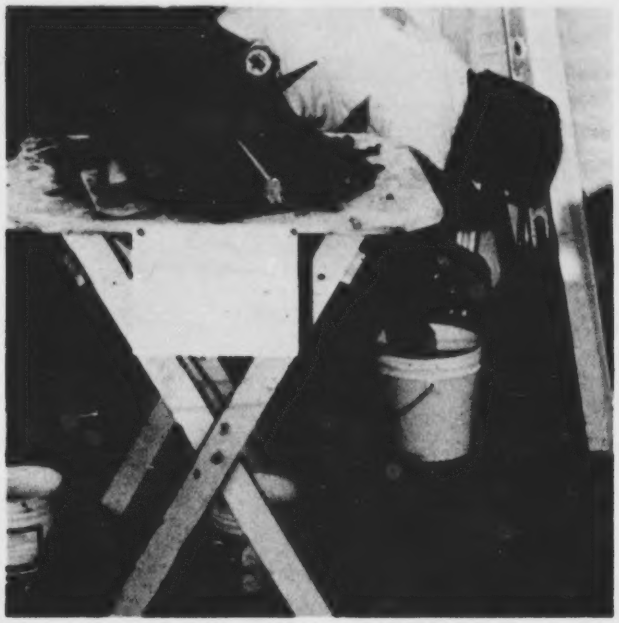


Fig. B-46. Mortarboard with stand in use

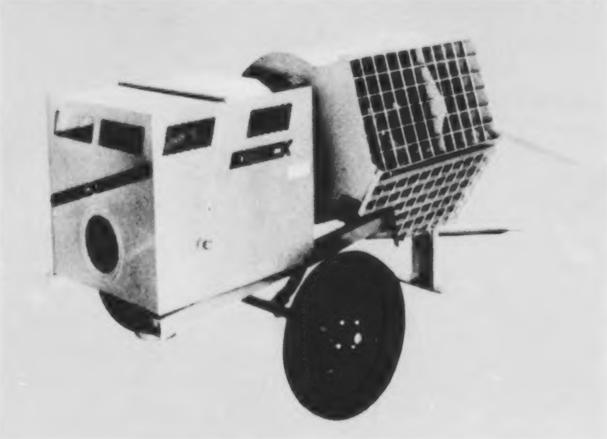


Fig. B-47. Mortar mixer

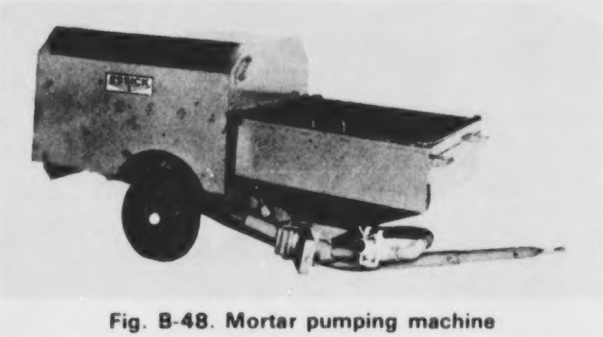


Fig. B-48. Mortar pumping machine

Special Tools

Specialized hand tools enable the tilesetter to perform a particular job more efficiently.

Metal Quarry Tile Rack

Metal quarry tile racks are available in many patterns, and they can be made to order for special patterns (Fig. B-49). They are used to maintain the same width between the quarry tiles.

Aluminum Marker

The aluminum marker is used for marking tiles for irregular cuts. It must be made from soft aluminum.

Scribe

Another tool used for marking tiles for irregular cuts is the tile scribe (Fig. B-50). It is made of steel and weighs approximately 1 ounce (28 grams).

Floating Strip

The floating strip is a wood strip approximately ¼ by 1½ inches (0.6 by 3.8 centimetres), cut to any desired length (Fig. B-51). It is a useful tool for the tilesetter when the plane of the setting bed is being established.

Beating Block

The beating or smoothing block is approximately 4 by 14 inches (10.2 by 35.6 centimetres) in size (Fig. B-52). It should be made of hardwood, such as maple, which does not warp readily. The block is used by the tilesetter to beat in the tiles so that they will be set permanently and will be flush with each other.

Scratcher

The tile scratcher or scarifier is used to roughen the scratch coat so that a satisfactory key will be provided for the float coat (Fig. B-53). It is usually a 4 by 5 inch (10.2 by 12.7 centimetre) piece of metal with notches on one edge. Some tilesetters make their own from metal lath or by driving nails through wood so that they protrude enough to give a series of sharp points.

Rubber Mallet

The rubber mallet is useful in setting large tiles that require considerable weight exerted on them (Fig. B-54). It does not splinter or wear out the straightedges or beating blocks when used on them.

Kneeling Board

Kneeling boards usually are made of ¾-inch (1.9-centimetre) plywood and are 30 to 36 inches (76.2 to 91.4 centimetres) long and 12 to 15 inches (30.5 to 38.1 centimetres) wide (Fig. B-55). Only boards that are unwarped, straight, and clean should be used. The tilesetter walks and kneels on them while installing floor tile.

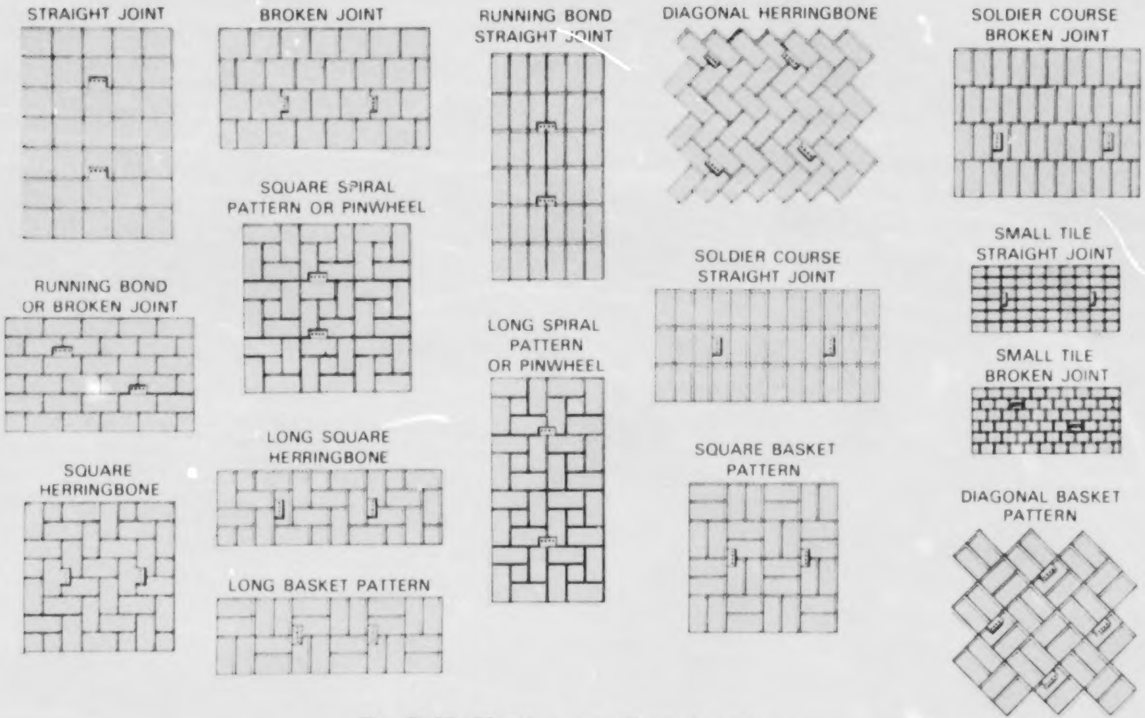

STRAIGHT JOINT
BROKEN JOINT
RUNNING BOND STRAIGHT JOINT
DIAGONAL HERRINGBONE
SOLDIER COURSE BROKEN JOINT
SQUARE SPIRAL PATTERN OR PINWHEEL
SMALL TILE STRAIGHT JOINT
SOLDIER COURSE STRAIGHT JOINT
RUNNING BOND OR BROKEN JOINT
LONG SPIRAL PATTERN OR PINWHEEL
SMALL TILE BROKEN JOINT
LONG SQUARE HERRINGBONE
SQUARE BASKET PATTERN
SQUARE HERRINGBONE
DIAGONAL BASKET PATTERN
LONG BASKET PATTERN

Fig. B-49. Metal quarry tile rack patterns

Fig. B-50. Tile scribe in use

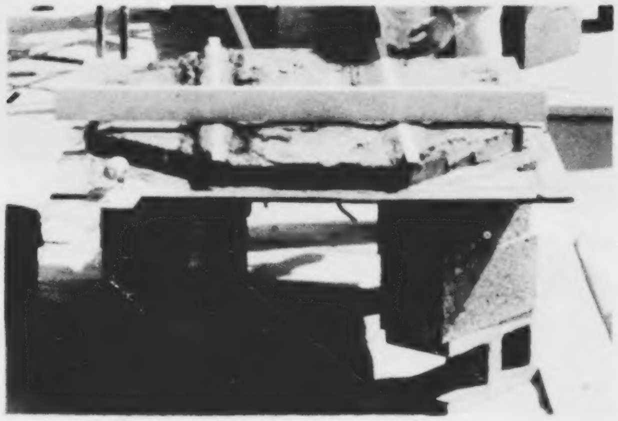


Fig. B-51. Floating strip in use

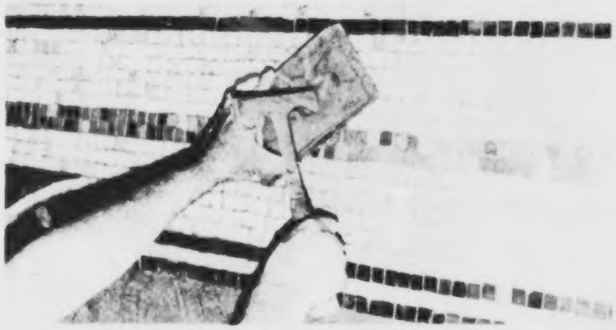


Fig. B-52. Beating block in use

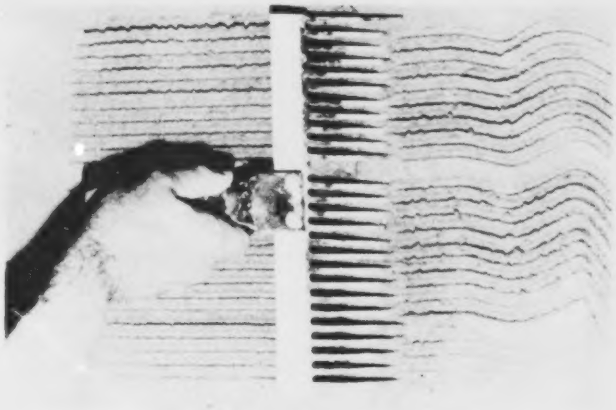


Fig. B-53. Tile scratcher in use

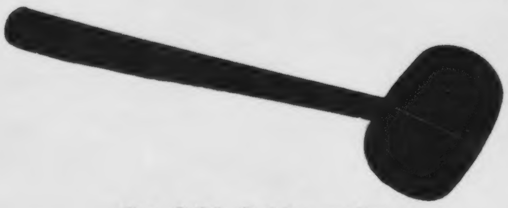


Fig. B-54. Rubber mallet

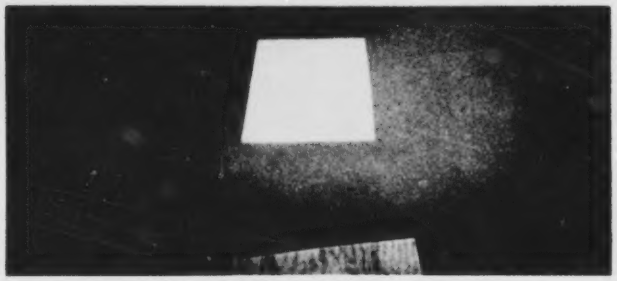


Fig. B-55. Kneeling boards

Scrub Brush

A scrub brush is used to remove excess mortar from the joints and the face of the tile (Fig. B-56). The preferred size is approximately 2¾ by 8 inches (7 by 20 centimetres).

Water Brush

The water brush, which is usually of the Dutch brush type, is used to wet mortar and to dampen walls and floors (Fig. B-57).

Notched Trowel

Notched trowels are available in the serrated and square-tooth design (Figs. B-58 and B-59). The teeth are made in various sizes. The correct tooth size and depth must be used to apply the thickness of bonding mortar specified. These trowels are used to apply all of the various kinds of bonding materials for ceramic tile. When the teeth become worn, the trowel has to be resharpened or replaced (Figs. B-60 and B-61).

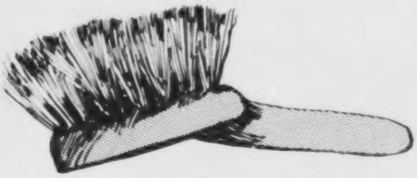


Fig. B-56. Scrub brush

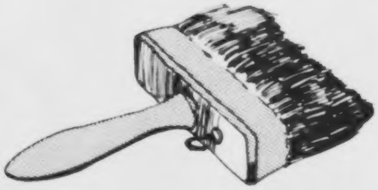


Fig. B-57. Water brush

Caulking Gun

The caulking gun is used by tilesetters to fill corners and edges (Fig. B-62).

Power Grouter

Electric- or gasoline-powered machines are available for grouting ceramic tile floors (Fig. B-63). Three 14-inch (35.6-centimetre) rubber-faced blades cover an area of approximately 6 square feet (0.54 square metre). The blade angle may be changed to accommodate a variety of grout consistencies, including sand-cement and epoxy. The trowel speed ranges from 50 to 110 rpm. The operator controls the direction, speed, and angle of the blades from a standing position.

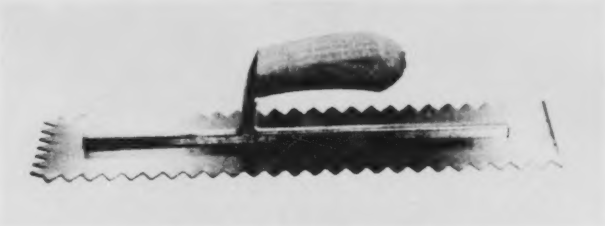


Fig. B-58. Serrated trowel

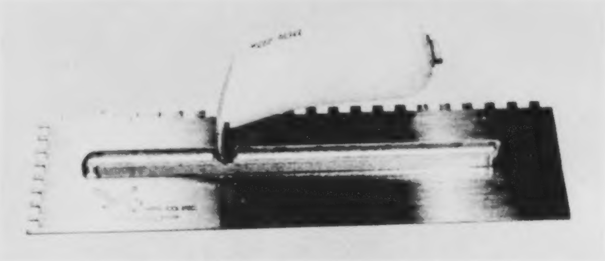


Fig. B-59. Square-tooth notched trowel

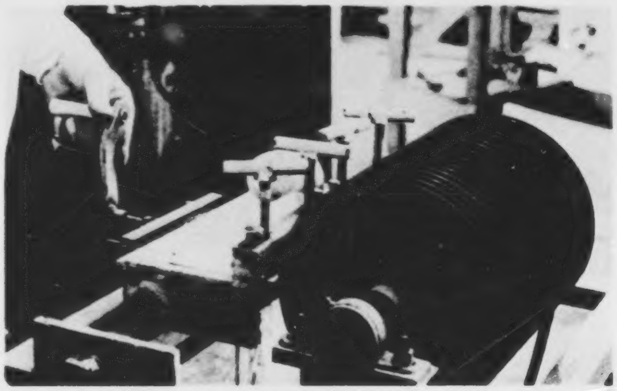


Fig. B-60. Notched trowel sharpener in use

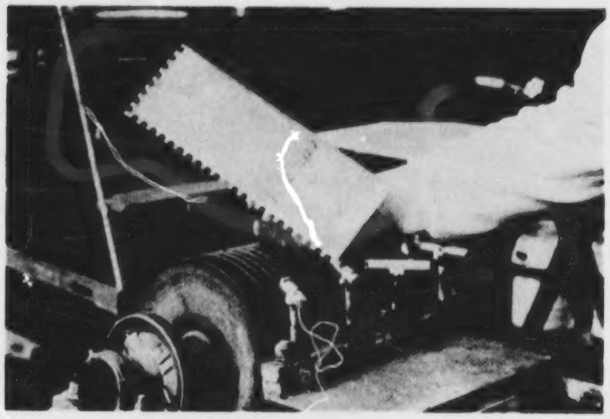


Fig. B-61. Notched trowel after resharpening

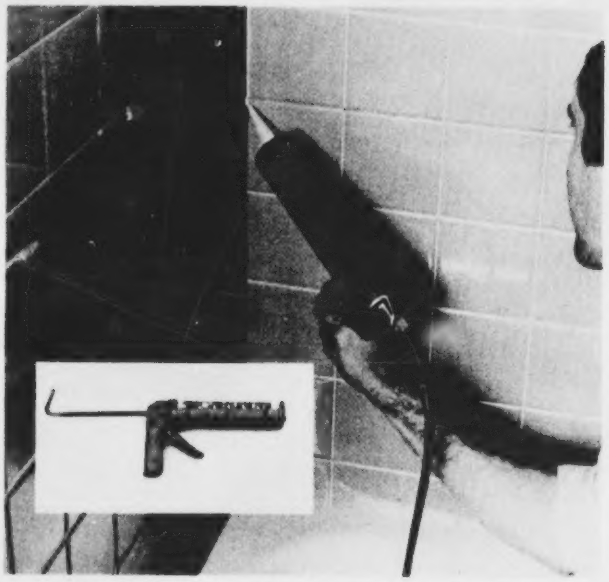


Fig. B-62. Electric caulking gun in use (manual gun in inset)

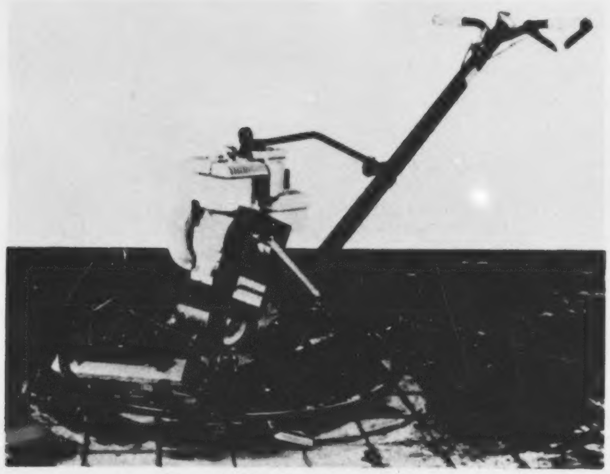


Fig. B-63. Power grouter

Basic Equipment

The tilesetter provides most of the small tools that are needed on the job. They are small enough to be carried easily in a toolbox.

Toolbox

One of the most important pieces of equipment used by the tilesetter is a toolbox (Fig. B-64). The style of the box is a matter of individual preference. The box should be light enough to be carried to different job locations and strong enough to take hard wear.

Claw Hammer

The tilesetter can find many uses for the claw hammer (Fig. B-65). The straight-claw hammer is not as satisfactory for pulling nails as the curved-claw hammer, but it is better for fastening tar paper and expanded metal lath. It can also be used for nailing screeds in place, chipping or scraping semidry mortar, and removing plaster.

Care should be exercised in the use of this tool. Burrs on the head or claws should be ground off as they occur to eliminate the danger of chips of steel flaking off in use. Striking one head against another is also dangerous because it can cause chips to penetrate an eye.

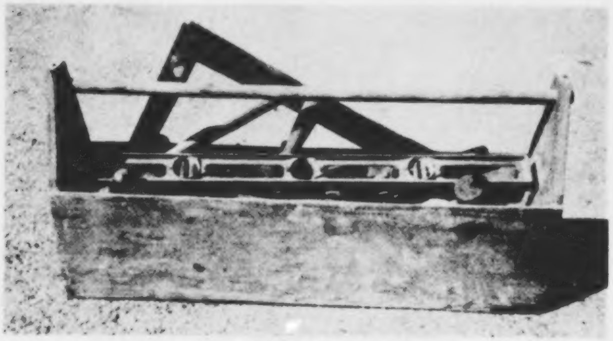


Fig. B-64. Toolbox

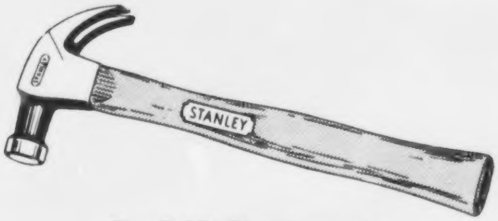


Fig. B-65. Claw hammer

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UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 7 — MORTAR TOOLS AND OTHER SPECIAL TOOLS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. In comparative size, the buttering trowel is _1_ than the brick trowel. 1. ________
2. Hawks usually are made of _2_. 2. ________
3. The hawk generally used by tilesetters is _3_ inches square. 3. ________
4. The trowel used with the hawk for transferring mortar from the mortarboard to the wall is the _4_ trowel. 4. ________
5. The most necessary trowel for the tilesetter is the _5_ trowel. 5. ________
6. Notched trowels are used to apply _6_ materials for ceramic tile. 6. ________
7. The water brush used by the tilesetter usually is a(n) _7_ type. 7. ________
8. Large mortar mixers are powered by _8_. 8. ________
9. When a mortar machine is used, mortar can be forced through hose _9_ stories high. 9. ________
10. The capacity of the bucket usually referred to in specifications is _10_ quarts. 10. ________

TOPIC 8 — GROUTS

This topic is planned to provide answers to the following questions:

- **What grouting materials are used in tilesetting?**
- **How are grouts prepared?**
- **Where are special grouts needed?**

Grouting or filling of the tile joints is too important an operation to be left in the hands of an unskilled or unsupervised worker. A poor grouting job can ruin the appearance of any tilework. The good journey-level tilesetter does the work or supervises the helper who is doing this portion of the work. In addition, the competent tilesetter learns the properties of the different types of grouts in order to determine the most satisfactory one for each job.

Mixing grout is a very exacting operation. Most of the objectionable foreign matter in finished grout jobs comes from the containers and tools that have been used to prepare and work the grout. Experience has taught the tilesetter to keep a set of tools just for mixing, a bucket for the grout mixture, and a bucket for the clean-up water. Mortar buckets and tools should never be used for mixing and applying grout. The sand and cement from the mortar will come off in the grout mixture and will then show up as unwanted flaws in the finished job.

The water used in mixing grout should never be hot or warm. Only clean buckets and containers should be used for carrying the water, holding the clean-up water, and mixing the grout. No foreign matter should be allowed in the mixture. The grout should be mixed thoroughly to give a uniform consistency. It should be allowed to slake or gel as recommended by the manufacturer.

A grout mixture that has been in an open container too long should not be used. Neither should it be remixed with water, because it will be crumbly. The use of such a grout would only detract from the beauty of a tile job.

Soft, chalky grouting usually is an indication of inferior work. The grouting should be hard, white, and smooth.

The tilesetter should closely follow the manufacturer's specifications when mixing and using grouts, particularly the special grouts.

To meet normal wear conditions, a grout must be strong and dense. In the regular maintenance of floors, some building superintendents will select strong crystallizing cleansers, such as soda ash, and certain phosphates and sulphates or combinations of these. If the grout is absorptive and porous, these cleansers will penetrate the grout and, on drying, will crystallize within the pores of the grout. In time, the crystals can develop to such size and strength that they gradually will disintegrate the grout. To prevent this, the tilesetter should use a good dense mix and compact it well into the joint.

Portland Cement Grout

Portland cement grouts are used where floors and walls are to be subjected to normal service.

Grout for Ceramic Tiles

In former years the grout used in the installation of tile was a neat gray or white portland cement mixed with water to a creamy consistency. The gray portland cement is still being used for ceramic mosaic floor tiles; however, a number of changes have been made in the white portland cement grouts. Manufacturers have added ingredients to make them smoother, whiter, and more uniform in color; to make them waterproof; and to reduce shrinkage. These are referred to as "proprietary" grouts; and if the manufacturer formulates them correctly, they are suitable for use with glazed ceramic wall tile and ceramic mosaic tile.

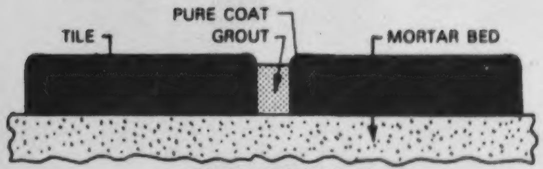
A grout joint should have the following characteristics:

1. Uniform color
2. Absence of pure coat or setting material
3. Density and cure to the maximum hardness
4. Smoothness without voids, pinholes, or low spots
5. Finish flush to the top of square-edged tile (Fig. B-66)
6. Finish tooled or struck to the depth of the cushion on cushion-edged tile (Fig. B-66)
7. Absence of all grout from the face of the tile when the job is finished

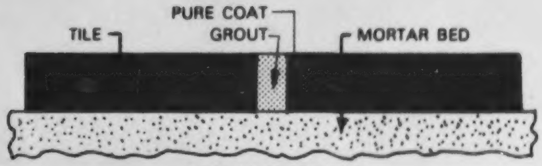
Care should be taken to achieve all of these characteristics, but perhaps the most important is item 3. To cure portland cement grout correctly, water must be present. The tiles should be moistened before the grout is applied, and the finished tilework should be covered for at least three days to retain moisture.

Proprietary Grouts

Many specially compounded white or colored waterproof grouts are available for use with glazed ceramic wall tiles. Some of these grouts are used with dry or



CUSHION-EDGED TILE



SQUARE-EDGED TILE

Fig. B-66. Correct way to finish grout

unsoaked tiles that have been installed with adhesives or special thin-set portland cement mortar. These grouts are sold under various proprietary trade names and are also known as commercial grouts. Basically, they are compounded from white portland cement and opaque whitening materials (such as titanium oxide) plus waterproofing additives (such as zinc stearate or aluminum stearate). The addition of the waterproofing materials makes the grout more difficult to mix in water, but the finished surface will be water repellent and easier to clean.

In addition to the whitening and waterproofing agents, proprietary grouts also contain certain water-retentive additives to hold the mixing water within the grout mix until the grout is cured and set. Small amounts of accelerators, such as calcium chloride, also are used to ensure an early set of the cement. The grouts carry trade names that usually indicate their intended use.

Care should be taken to use a minimum of water in mixing these proprietary grouts because the grout paste should be kept stiff. Excessive water makes a sloppy mix or slurry, resulting in a more porous and absorptive grout that quickly becomes soiled in service.

Coloring Pigments

Tilesetters often are called upon to produce special grout colors; however, they should be careful in handling this type of request because many coloring pigments change once they are in contact with the strongly alkaline mix of portland cement and lime. Some pigments react slowly, and the color will change over an extended period of time. The colored grouts that appear to be successfully mixed initially may require replacement later on.

The job of coloring grouts should be placed in the hands of reputable manufacturers of grout or specialists in colored stucco. Even the use of high-quality colored grouts does not guarantee a uniform surface color.

A satisfactory application of colored grout requires a uniform smoothness and texture over each joint area. To obtain this effect, the tilesetter should rub and trowel the area. Otherwise, the color in the joints will appear splotchy and uneven.

Grout for Quarry Tile

A recommended grout formula for a quarry tile floor is waterproof plastic portland cement or common portland cement mixed with one to two parts of sand.

To make regular portland cement water repellent, the tilesetter can use a mix containing ammonium stearate paste in an amount of one quart (0.9 litre) to one sack of cement. Some tilesetters use aluminum stearate powder in a proportion of 2 to 3 percent to the portland cement content.

Silicone and Polyurethane Grouts

Some tile manufacturers of both ceramic mosaic tiles and glazed wall tiles are producing sheets of tiles and pregrouting them at the manufacturing plant.

Polyurethane grout has been used to pregrout ceramic mosaic tile. Some touch-up work usually is needed after the premounted and pregrouted sheets are installed. A compatible polyurethane bonding adhesive is used to install the ceramic mosaic tile.

Silicone grouts are used to premount and pregrout glazed wall tile. A caulking gun is then used to grout the joints between the sheets of tile and at the corners.

A technique also has been developed to install tiles one by one, in the usual manner, but to grout the entire installation with silicone grout using a caulking gun.

Silicone grout is not to be used on kitchen counter tops or other surfaces used for food preparation. This is because the safety of the use of silicone for food preparation surfaces has not been determined by the state or federal food and agricultural agencies.

Acid- or Alkali-Resistant Grouts

Quarry tile, paver tile, and other heavy-duty ceramic floor tiles are subjected to different types of chemical action. Grouting material for these tiles should be selected carefully to ensure that the grout will meet the service requirements of the tile installation. The grout should be resistant to acids or alkalies.

The tilesetter should know whether the tilework is to be exposed to normal service conditions or to special service conditions. For example, office building floors are subjected to normal wear and tear; exterior roof decks are subjected to all kinds of weather, including freezing temperatures; and tile floors in metal-cleaning plants, breweries, dairies, bakeries, and kitchens are exposed to special service conditions.

Tile linings of chemical tanks in storage bins are examples of special tile installations that require extra attention from the tilesetter. Grouts that are suitable for such special service conditions would be suggested by the tile contractor or the tile manufacturer.

Resin-Based Cement Grouts

Cement grouts with a resin base are excellent as a bond coat or as a grout to meet the service conditions that exist in dairies, chemical plants, breweries, distilleries, food and beverage plants, and kitchens. Resin-based grouts contain a liquid and a powder and have a limited pot life or working time. These grouts may be used as the bond coat under the tilework and as the filler for the grout joints.

When the resin-based cement grout is used only as a grout, certain precautions must be taken to neutralize the portland cement surface that would come into contact with the resin of the grout. First, the setting material made of portland cement must be removed because it may have penetrated into the joint. Then, the joint should be flushed with a solution of muriatic acid before the grout is applied. An acid solution recommended by the grout manufacturer should be used because a strong solution can ruin the installation.

Epoxy Grouts

Epoxy grouts also come in two parts, both of which are heavy liquids.

These materials can be used both for bonding the tile and for grouting. When mixed together, their pot life is short, and the tilesetter who uses them must be skillful. Tests have shown that these materials suffer no effects of any consequence from hydrochloric and sulfuric acids or from alkaline materials such as washing soda, caustics, soaps, and detergents. They also are highly resistant to greases, oils, and alcohol.

Silicate Grouts

A grout of sodium silicate and cement has a satisfactory service life under continuous acid conditions; however, it is not intended for use in areas in which alkalies or caustics are present or where these chemicals are used for cleaning.

Sodium silicate grout is a two-component mix containing an alkaline silicate liquid and a dry powder mixed with a fine silicate fast-setting additive. It should not be used over a portland cement base unless an insulating and impervious asphalt membrane or a hot-mopped tar membrane is applied between the grout and the base.

Lumnite Cement Grouts

A special grout that is based on lumnite cement with additives has demonstrated a satisfactory service life when used in areas in which moderate acid conditions exist, such as in dairies and kitchens, and is as easy to apply as portland cement grout.

Although lumnite cement grout is more expensive than portland cement grout, it is considerably less costly than some of the resin-type cement grouts. Many tilesetters feel that lumnite cement grout is a good investment in tilework, even though it will require more maintenance than some of the more costly and more difficult-to-install materials.

Study Assignment

American National Standard Specification A108.1. Read sections on grouting.

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 8 — GROUTS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. A small amount of calcium chloride in the mix will ensure a(n) _1_ _2_ of the cement.
2. The tilesetter should _3_ the grout well into the joint.
3. Grout left in an open container too long becomes _4_.
4. To meet normal wear conditions, a grout must be strong and _5_.
5. Lumnite cement grouts may be used in areas exposed to _6_ _7_ conditions.
6. The _8_ - _9_ cements are useful as both grout and bond coat when the tilework is located in food or beverage plants.
7. The specially compounded proprietary grouts are intended primarily for use with _10_ _11_ wall tile.
8. Proprietary grouts should be mixed so that the paste is _12_.
9. To cure portland cement grout correctly, _13_ must be present.
10. For quarry tile floors subjected to normal service conditions, a grout mixture of portland cement and _14_ to _15_ parts of sand is satisfactory.

1. ________
2. ________
3. ________
4. ________
5. ________
6. ________
7. ________
8. ________
9. ________
10. ________
11. ________
12. ________
13. ________
14. ________
15. ________

TOPIC 9 — INSERTS AND ACCESSORIES

This topic is planned to provide answers to the following questions:

- **What accessories will the tilesetter install?**
- **How are inserts and accessories installed?**

Correctly installed and balanced inserts and accessories in tilework will beautify and enliven the appearance of any tile installation. Bathroom fixtures made of vitreous china or plated with chromium are styled by different manufacturers to blend with any decor; these accessories are designed to be attractive as well as useful (Fig. B-67).

Tilesetters should know of the different bathroom accessories that are available, because if they are installed in tilework, they come within the province of the tilesetting trade. Members of another trade install any fixtures or accessories that are to be mounted on plaster walls. Regardless of which trade has jurisdiction over any particular job, the apprentice tilesetter should learn how to balance and center these accessories, how to build the proper cradles to receive them, and how to use the correct techniques for installing them clear of pipes and studding. Manufacturers are constantly adding new designs and varying old ones. The skilled tilesetter should be prepared to handle any type of installation. An exceptional installation is shown in Fig. B-68.

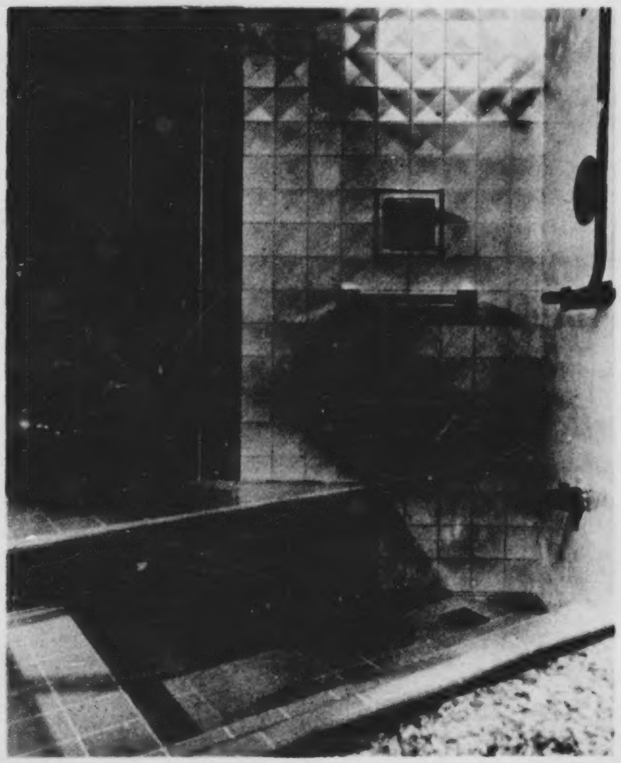


Fig. B-67. Bathroom tile installation showing accessories

Towel Bars

Towel bars are made of both china and metal. When lugs are set for the posts of bars, care must be taken to measure from center to center of the lug holes. Towel bars are manufactured in the following lengths:

Inches (centimetres)

18 (45.7)
24 (61)
30 (76.2)
36 (91.4)

Soap Dishes

Various types of soap dishes are available in both chrome and china. Those made of china are sometimes colored to match the tile or plumbing fixtures. Soap dishes come in flush, projecting, and semirecessed types. They are sized to fit into a particular unit of tilework. Some of the more common sizes are the following:

Inches (centimetres)

6 by 3 (15.2 by 7.6)
6 by 6 (15.2 by 15.2)
4¼ by 4¼ (10.8 by 10.8)
4¼ by 6 (10.8 by 15.2)

Soap Holders with Grab Bars

Soap holders with grab bars are made of either chrome or china. They are no longer being recommended by most authorities in the tile industry. A danger exists to persons using the grab bars if the bars should become dislodged while being used. Grab bars are still on the market, and the apprentice should install what is specified for the job or what the employer tells him or her to install. The apprentice should know the best recommendations from the tile trade. For maximum safety the tile industry recommends the use of a nonceramic grab bar that is anchored mechanically to the structural wall.

Paper Holders

Paper holders are available in both china and chrome and in surface and recessed types. The rollers

See color reproduction on page 124.

Fig. 8-68. Tiled pullman

are either chrome or wood. Surface-type holders usually measure 6 inches (15.2 centimetres) from center to center of the posts. Both china and chrome accessories can be set with screws or keyed in with cement. Recessed-type holders generally require one of the following wall openings:

Inches (centimetres)

4¼ by 4¼ by 1⅝ (10.8 by 10.8 by 4.1)
6 by 6 by 2 (15.2 by 15.2 by 5.1)
5¼ by 5¼ by 2 (13.3 by 13.3 by 5.1)

Another type of recessed holder is available—the concealed type, which consists of a recessed shell that is sometimes fitted with an inner revolving hood. This type generally takes wall openings of 5⅝ by 5⅝ by 3 inches (14.3 by 14.3 by 7.6 centimetres) and has overall dimensions of 6½ by 6½ inches (16.5 by 16.5 centimetres). Another type is the paper holder for folded paper (sheet type), which takes wall openings of 4¼ by 5½ by 2 inches (10.8 by 14 by 5.1 centimetres) or 3¾ by 5 by 1⅝ inches (9.5 by 12.7 by 4.1 centimetres), depending on whether it is recessed or on the surface.

Concealed Lavatory Units

The concealed lavatory unit is a chrome-plated accessory designed for several uses, with a flush revolving door to which is attached a soap dish, tumbler holder, and toothbrush holder. Wall openings are usually 6½ by 8⅛ by 3½ inches (16.5 by 20.6 by 8.9 centimetres), and the overall size of the flange is 7⅜ by 8⅝ inches (18.7 by 21.9 centimetres). The concealed lavatory unit is designed either to be set into the wall with screws or to be keyed into the wall with cement.

Medicine Cabinets

The medicine cabinet usually is the focal point in most bathrooms; therefore, particular care should be taken to center the openings in the tilework. The specifications may indicate that the tilesetter should set the medicine cabinet.

Metal-Plate-Type Accessories

Metal plates for bathroom accessories are sometimes furnished. They are fastened to the walls with screws. Lag screws or toggle bolts should be used, but wood plugs should never be used. (For more information on these fasteners, see the *Introduction to Apprenticeship.*) The moisture in the mortar will cause the wood plugs to swell and, upon drying, the wood will shrink, leaving a loose insert or accessory on the tilework.

Plates with concealed screws or brass anchors are available. Manufacturers specify which recessed types are designed to be mounted permanently with cement or mortar and which types are to be attached to recessed cuts in walls with screws or toggle bolts.

Care should be taken in placing accessories in the bathroom. The tilesetter should consult with the homeowner or resident as to the location of important fixtures, such as towel bars or hooks.

Miscellaneous Items

Chrome towel rings, robe hooks, ashtrays, soap holders, toothbrush holders, and stainless-steel shelves are other fixtures that may be installed in a tile installation. The tilesetter should check the specifications to see whether all the accessories included are balanced and centered in a tile job.

UNIT B — TILE, MATERIALS, AND TOOLS

TOPIC 9 — INSERTS AND ACCESSORIES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The three important things to be learned by anyone who may be called on to install bathroom accessories are how to balance and ___1___ them, how to build the proper ___2___ to receive them, and how to install them to be clear of ___3___ and studding.

1. ________
2. ________
3. ________

2. Bathroom accessories come within the jurisdiction of the tilesetter when they are installed in ___4___ .

4. ________

3. To fasten the metal plates used with some bathroom accessories, lag screws or ___5___ ___6___ should be used.

5. ________
6. ________

4. The tilesetter should never use ___7___ ___8___ to fasten the metal plates.

7. ________
8. ________

5. The ___9___ may indicate that the tilesetter should install a medicine cabinet.

9. ________

6. Most bathroom accessories are fastened with screws or keyed to the wall with ___10___ or mortar.

10. ________

7. Most bathroom accessories are made of vitreous china or plated with ___11___ .

11. ________

8. Ceramic ___12___ ___13___ are no longer being recommended, because they can be unsafe.

12. ________
13. ________

9. Surface-type paper holders usually measure ___14___ inches from center to center of the posts.

14. ________

10. Grab bars should be ___15___ to the structural wall.

15. ________

TOPIC 10 — EXPANSION JOINTS AND ELASTOMERIC SEALANTS

This topic is planned to provide answers to the following questions:

- **What are the basic components of an expansion joint?**
- **How are elastomeric sealants used?**
- **How can sealant failures be avoided?**

Designs and uses of ceramic tile in modern structures have established heretofore unrealized degrees of creativity for the architect and contractor. However, with the expanded uses of tile for the finish of all types of interior and exterior surfaces, certain specific problems arise and continue to increase.

One of the most prominent problem areas is the use and design of expansion joints and the related application of a correct caulking sealant.

Any structure, new or old, is constantly being subjected to thermal shock, vibration, settling, and loading stresses. Needless to say, it can be disastrous to disregard the fact that temperature changes alone create sufficient contraction and expansion in all types of building materials (including tile) to cause problems.

Past and present failures in tile installations in the form of buckling surfaces, ruptures, fractures, and cracks can be traced to the fact that expansion joints were not incorporated or even considered. It must be remembered that a completed tile surface is a dynamic structure that cannot be contained within the static confines of a fixed perimeter without space in which to move. The thermal expansion of building materials is a small indication of the total number of factors that must be taken into consideration when planning the installation of a large tile surface (Table B-1).

As already noted, the entire installation is not only subjected to thermal shock but also to many mechanical movements, all of which further emphasize the need for expansion joints.

Basic Joint Design

Certain basic guidelines should be remembered when allowing for "space" in which the tile surface may move. As indicated in Table B-1, a rise in the surface temperature of masonry to 150° F. (66° C) creates an average movement of 0.056 to 0.063 inch (0.14 to 0.16 centimetre) for every 10 linear feet (3 linear metres) of tile expanse.

Surface temperatures vary over a much wider range than the corresponding air temperatures; they may be as much as 50° or 60° F. (10° or 15° C) warmer than the air during the heat of the day, and perhaps 10 degrees colder on a cold night.

When thermal variations alone are used as the basis of calculating joint size, the recommended dimensions shown in Figs. B-69 and B-70 can be established as the minimum points of consideration when allowing for expansion joints. This is based on the fundamental requirement that joints will be provided for every 16 to 20 feet (5 to 6 metres) of tile expanse for exterior surfaces and for every 30 to 40 feet (9 to 12 metres) of tile expanse for interior surfaces.

To select the best joint design, the tilesetter should consider carefully the size of the joint, the frequency of joints, the backup filler, and the caulking sealant. The tilesetter who considers each of these factors will be able to produce good expansion joints and avoid many of the most frequently encountered problems.

Size of Joint

The size of a working butt joint can range from a minimum of ¼ by ¼ inch (0.6 by 0.6 centimetre) to a maximum of 1 by ½ inch (2.5 by 1.3 centimetres). A working lap joint can be from ⅛ to ½ inch (0.3 to 1.3 centimetres) in width. The depth of all joints should extend to the substrate.

Frequency of Joints

The joints in exterior tile should be placed 16 to 20 feet (5 to 6 metres) on center. Interior tile joints should be placed 30 to 40 feet (9 to 12 metres) on center. Joints should be placed at all points on the horizontal periphery.

Backup Filler

A backup filler is used to support the caulking sealant when the depth of the joint exceeds ½ inch (1.3 centimetres). Only polyethylene or polyurethane flexible foam should be used as backup filler.

Caulking Sealant (Adhesive/Elastomeric Type)

Caulking sealants made of silicone rubber are recommended for all interior and exterior applications.

Polysulfide sealants are used primarily for exterior installations. They should not be used for exposed interior applications or where discoloring or fading will produce undesirable effects.

Polyurethane sealants are used primarily for horizontal expansion joints.

Joint Caulking with Elastomeric Sealants

The importance of expansion joints cannot be overemphasized; however, their use on any surface will prove to be unsatisfactory if the correct sealant is not used to complete the installation.

Basically, the sealant must be able to absorb all movements in the joint without rupturing and without loss of adhesion to the joining surfaces. This means that it must have good adhesion, good extensibility, and sufficient tensile strength to prevent its failure under extension; it must be able to recover almost completely from forces without damage. The sealant must not only have these characteristics when installed, but it must also fully retain them over a period of many years.

These requirements generally are applicable to all forms of construction-type joint sealants; however, ceramic tile installations often create requirements beyond those outlined here. Many jobs require a sealant that will not fade, yellow, or stain, and that has a nonporous surface that will not absorb fungi or algae. Generally, such sealants must be used around sinks, bathtubs, food treatment areas, swimming pools, drainboards, and pullman bowls.

The silicone sealants have proved to be superior for these applications. Silicones have been found to exceed the performance capabilities of all other types

TAB[illegible] B-1
THERMAL EXPANSION O[illegible]UILDING MATERIALS

Material	Coefficient of thermal expansion, in./in.° F. (X 10^{-6})	Inches (cm) in 10 ft. (3 m) for temperature change of	
		150° F. (66° C)	180° F. (82° C)
Wood perpendicular to grain	1.9 to 3.2	0.034 to 0.039 (0.08 to 0.09)	
Wood parallel to grain	2.1 to 3.6	0.036 to 0.065 (0.09 to 0.16)	
Brick masonry	3.1	0.056 (0.14)	
Limestone masonry	3.5	0.063 (0.16)	
Plate glass	5.1	0.092 (0.23)	
Stainless steel, Type 430	5.8		0.126 (0.32)
Concrete	6.5	0.117 (0.29)	
Structural steel	6.7		0.144 (0.36)
Copper, 110	9.4		0.203 (0.51)
Stainless steel, Type 302	9.6		0.207 (0.52)
Red brass, 230	10.0		0.216 (0.54)
Architectural bronze, 385	11.0		0.238 (0.60)
Aluminum	12.9		0.279 (0.70)
Lead	15.9		0.342 (0.86)
Zinc, rolled	17.3		0.374 (0.94)
Plastics: Phenolics	8.5 to 25	0.153 to 0.450 (0.38 to 1.14)	
Glass-reinforced polyesters	10 to 14	0.180 to 0.252 (0.45 to 0.64)	
Acrylics	40 to 50	0.720 to 0.900 (1.82 to 2.28)	
Vinyl	24 to 40	0.432 to 0.720 (1.09 to 1.82)	

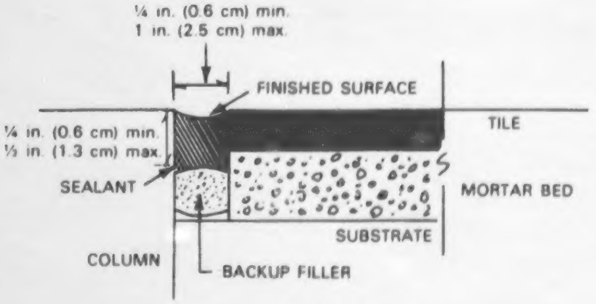


Fig. B-69. Working butt joint

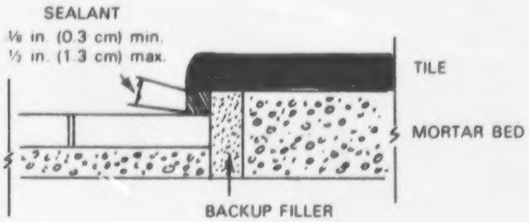


Fig. B-70. Working lap joint

of sealants and caulking compounds. Because the silicone sealants are easy to apply, labor costs should be reduced considerably when they are used.

The polysulfide rubber compounds also provide a dynamic joint sealant. Polysulfides have been in use throughout the construction industry for many years and have proved to be an acceptable caulking material for most exterior expansion joints. However, experience has shown that polysulfides tend to be porous and thus absorb foreign matter. They also become discolored over a period of time.

Polyethylene backup filler, when used in a working lap joint, as shown in Fig. B-70, creates a flexible shock mount. It absorbs all lateral movement caused by excessive thermal or mechanical stress.

Polyurethanes normally are used for horizontal expansion joints, rather than for vertical caulking applications. This is due primarily to the fact that flexible urethane elastomers are easily poured, cure to a Shore A hardness of 30 or more, and retain excellent abrasion-resistant characteristics. Occasionally, the polyurethanes encounter application problems because of the presence of moisture at the point of installation. This can create loss of bonding qualities, if not actual foaming of the material. Also, as stated previously, polyurethanes usually are compounded as a pourable sealant, and another type of material must be used for vertical joints.

When one standard material is to be used for both vertical and horizontal expansion joints, the material must meet the following requirements:

1. Solids content of 100 percent (no solvents)
2. Cured Shore A hardness of 30 to 40
3. Lap shear strength of 180 pounds per square inch (8 545 kilopascals)
4. Extensibility in ½ by ½ inch (1.3 by 1.3 centimetre) joint section of 100 percent at -40° F. (-40° C)
5. Maximum elongation of 400 percent
6. Compression recovery of 90 percent (40 percent compression for 22 hours at 160° F. or 71° C)
7. No change in color over 25 years (in an accelerated laboratory test)
8. No staining
9. Service temperature of -65° to +250° F. (-54° to +121° C)
10. Application temperature of -35° to +165° F. (-37° to +74°C)
11. One-part compound, not requiring mixing or special storage
12. Material stability, both in storage and at the point of application

A backup material can be used with the sealants in deeper joints (greater than ½ inch or 1.3 centimetres). The choice of this material is of prime importance. It must be compressible so that when the joint is compressed in width, it will not tend to force the sealant out. Further, it must be nonoily, nonstaining, and compatible with the sealant so as not to discolor or deteriorate it. Most importantly, this material must be one to which the sealant does not adhere. Materials that meet the requirements of a preformed backup filler include flexible polyethylene and polyurethane strip stock.

Formation of Expansion Joints

Expansion joints can be formed on vertical and horizontal surfaces (Fig. B-71). A suggested method of forming the expansion joint during the floating operation is as follows:

1. Set tile to predetermined point.
2. Cut mortar back to surface even with the tile.
3. Place wood stripping, which is cut to the specified width of the expansion joint. The strip should fit tight to the tile and back to the structural surface.
4. Float next section of mortar bed, and continue next section of installation.
5. In the case of a horizontal joint on a vertical surface, use tapered strips held in place by wedge inserts. Withdrawal of the inserts provides easy removal of the tapered strips.
6. Remove wood strips when the tile installation is completed.

Exterior Joints

Whenever the tile surface terminates at concrete curbs or retaining walls, expansion joints are to be provided. They also are needed directly over joints in structural floors (Fig. B-72).

Joints in the exterior fields of tile should be located every 16 feet (5 metres). They should not exceed 20 feet (6 metres) on center (Fig. B-73).

The size of the sealant (cross section) should not be less than ¼ by ¼ inch (0.6 by 0.6 centimetre) or larger than 1 by ½ inch (2.5 by 1.3 centimetres).

Backup filler should be used whenever possible as a means of economy and to prevent sealant from bonding to the substrate.

Interior Joints

Interiors, although they normally retain sufficient temperature control to avoid high thermal shock, require peripheral joints to absorb normal building movement caused by vibration and settling (Fig. B-74).

This also applies to the joints in the field of tile; however, because thermal variation is less than in an exterior installation, expansion joints can be placed every 30 to 40 feet (9 to 12 metres) on center (Fig. B-75).

The size of the sealant (cross section) should be not less than ¼ by ¼ inch (0.6 by 0.6 centimetre) nor larger than 1 by ½ inch (2.5 by 1.3 centimetres).

Backup filler should be used whenever possible as a means of economy and to prevent the sealant from bonding to the substrate.

Butt Joints

An expansion joint should be provided wherever a tile surface meets a metal structure, such as a door jamb. This butt joint will allow for the differences in coefficients of expansion and contraction.

Peripheral butt joints within rigid structures, such as concrete columns, must have provisions for expansion and contraction (Fig. B-76).

Joints in the field of tile on vertical surfaces must extend in depth to the last substrate, through the metal lath and scratch coat (Fig. B-77).

The size of the sealant (cross section) should not be less than ¼ by ¼ inch (0.6 by 0.6 centimetre) or larger than 1 by ½ inch (2.5 by 1.3 centimetres).

Backup filler should be used whenever possible as a means of economy and to prevent the sealant from bonding to the substrate.

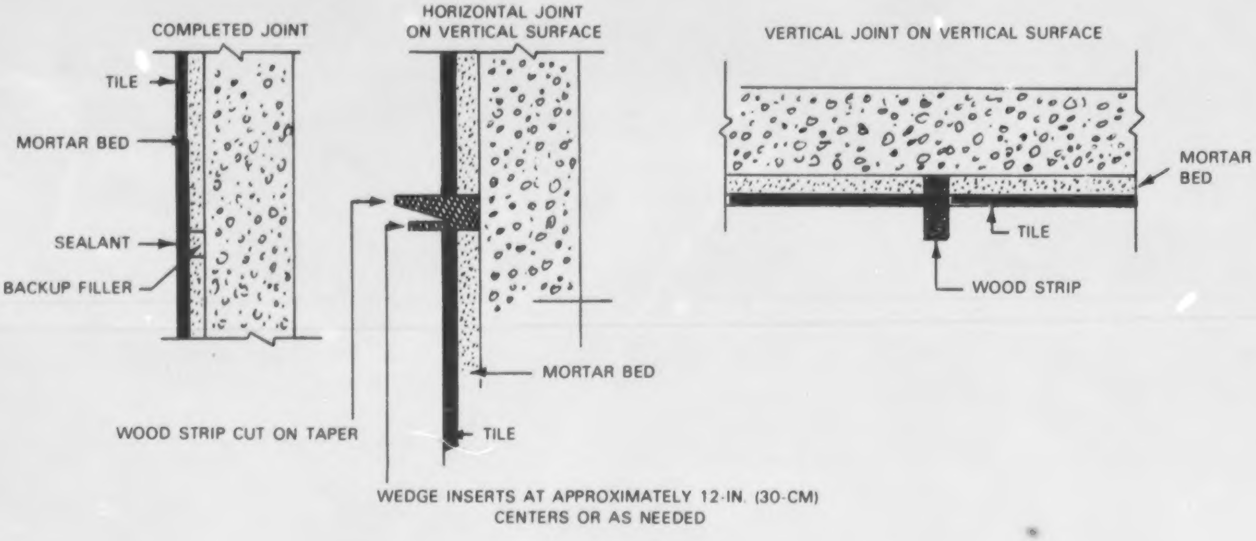

COMPLETED JOINT
TILE
MORTAR BED
SEALANT
BACKUP FILLER
HORIZONTAL JOINT ON VERTICAL SURFACE
MORTAR BED
TILE
WOOD STRIP CUT ON TAPER
WEDGE INSERTS AT APPROXIMATELY 12-IN. (30-CM) CENTERS OR AS NEEDED
VERTICAL JOINT ON VERTICAL SURFACE
MORTAR BED
TILE
WOOD STRIP

Fig. B-71. Forming expansion joints during the floating operation

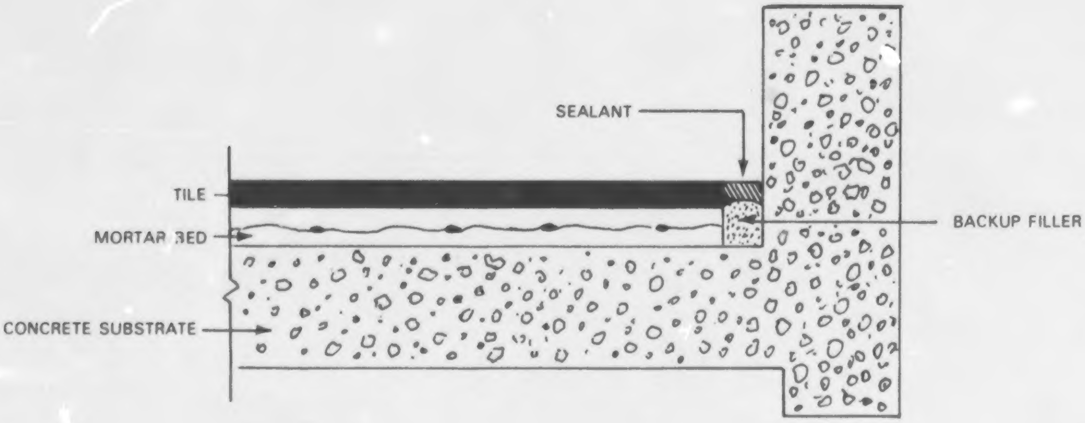

SEALANT
TILE
MORTAR BED
BACKUP FILLER
CONCRETE SUBSTRATE

Fig. B-72. Exterior peripheral joint (horizontal)

Residential and Commercial Installations

The joints in the areas illustrated in Fig. B-78 are subjected to thermal shock, settling, loading stress, and vibration. Normal grout will crack and fall away at these joints. This problem can be eliminated by replacing the grout with a silicone elastomeric sealant. A silicone sealant is especially recommended here because of its nonporous surface and its color retention stability. Algae or fungi will not penetrate the surface. The grout line or sealed joint is easily cleaned during normal use.

The joint size in this type of installation depends upon the structure to be sealed (Fig. B-78). Where possible, a ⅛-inch (0.3-centimetre) bead (usually of the glazing type) is recommended. Backup filler normally is not required, because the area to be sealed is usually small.

Whenever old grout is replaced, surfaces should be cleaned and prepared in accordance with the sealant manufacturer's instructions.

Industrial Installations

The use of quarry tile for floor and wall surfacing in industrial applications has long been an accepted practice. The growing use of quarry tile in such installations as breweries, bakeries, bottling plants, commercial kitchens, dairies, chemical processing plants, and laboratories involves the same problems as were described in the preceding discussions of standard tile installations; however, these same problems are greatly increased.

The use of alternating cold and hot liquids in and on these surfaces creates thermal shock problems that are often twice as difficult as those of normal installations. These surfaces must withstand the corrosive effects of acids and alkalies, constant moisture attack, excessive loading, and heavy traffic. The basic tile is capable of withstanding all of these elements; however, normal tile grout cannot endure such stresses unless expansion joints are provided. These problems can be solved by the use of an elastomeric sealant that

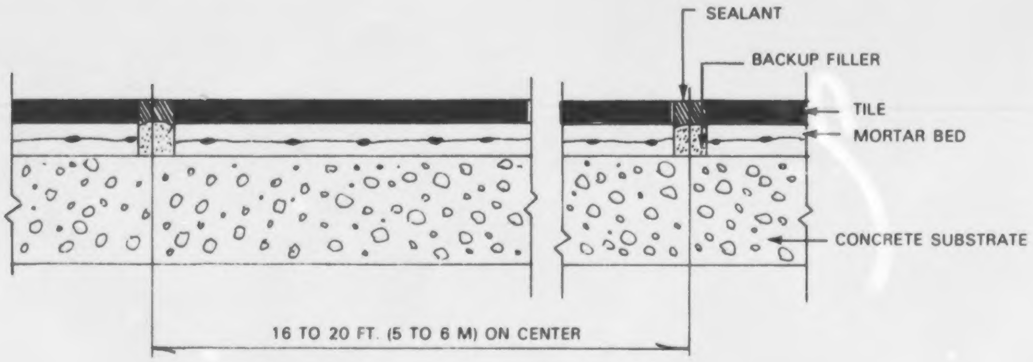


Fig. B-73. Exterior field joint (vertical and horizontal)

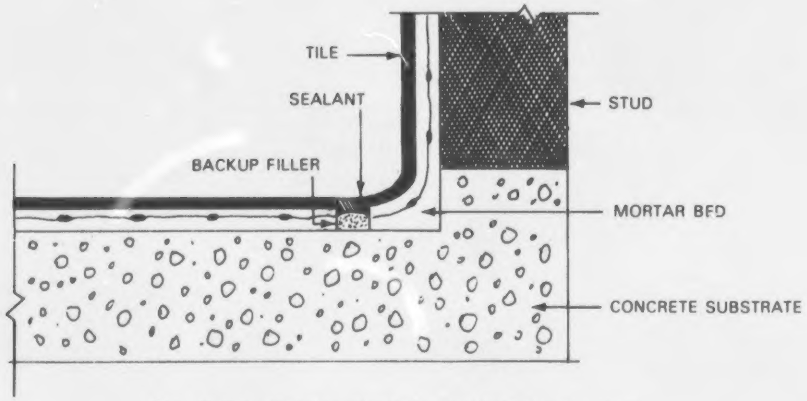


Fig. B-74. Interior peripheral joint (horizontal)

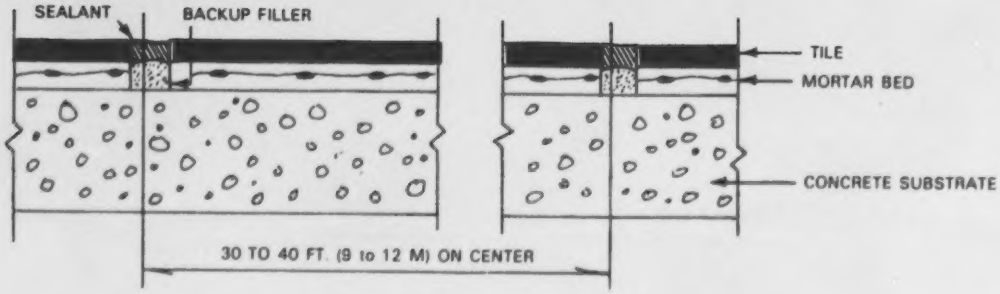

SEALANT
BACKUP FILLER
TILE
MORTAR BED
CONCRETE SUBSTRATE
30 TO 40 FT. (9 to 12 M) ON CENTER

Fig. B-75. Interior field joint (horizontal)

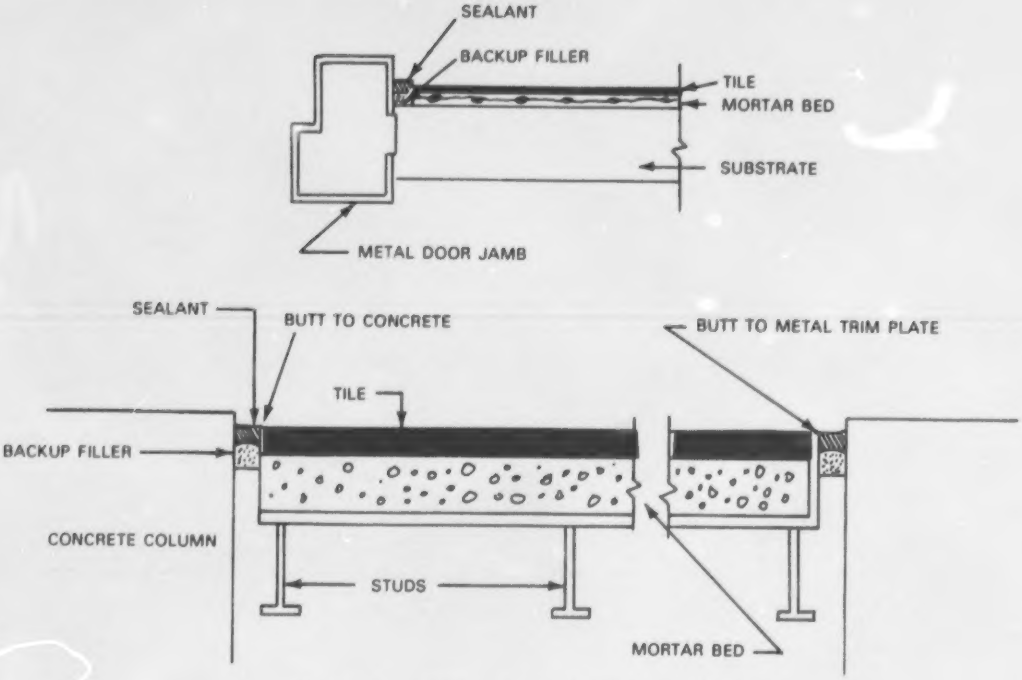

SEALANT
BACKUP FILLER
TILE
MORTAR BED
SUBSTRATE
METAL DOOR JAMB
SEALANT
BUTT TO CONCRETE
BUTT TO METAL TRIM PLATE
TILE
BACKUP FILLER
CONCRETE COLUMN
STUDS
MORTAR BED

Fig. B-76. Peripheral butt joint (vertical)

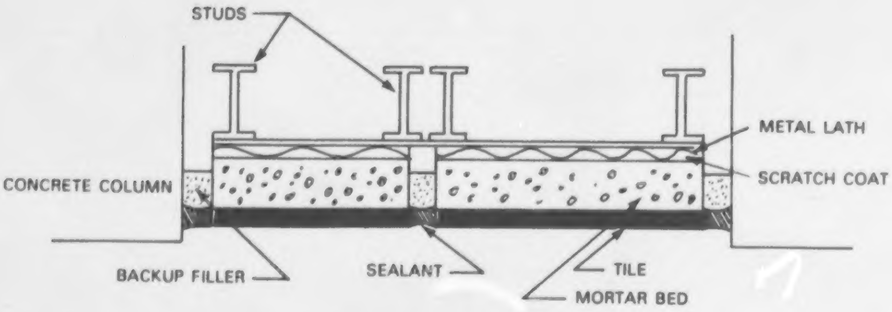
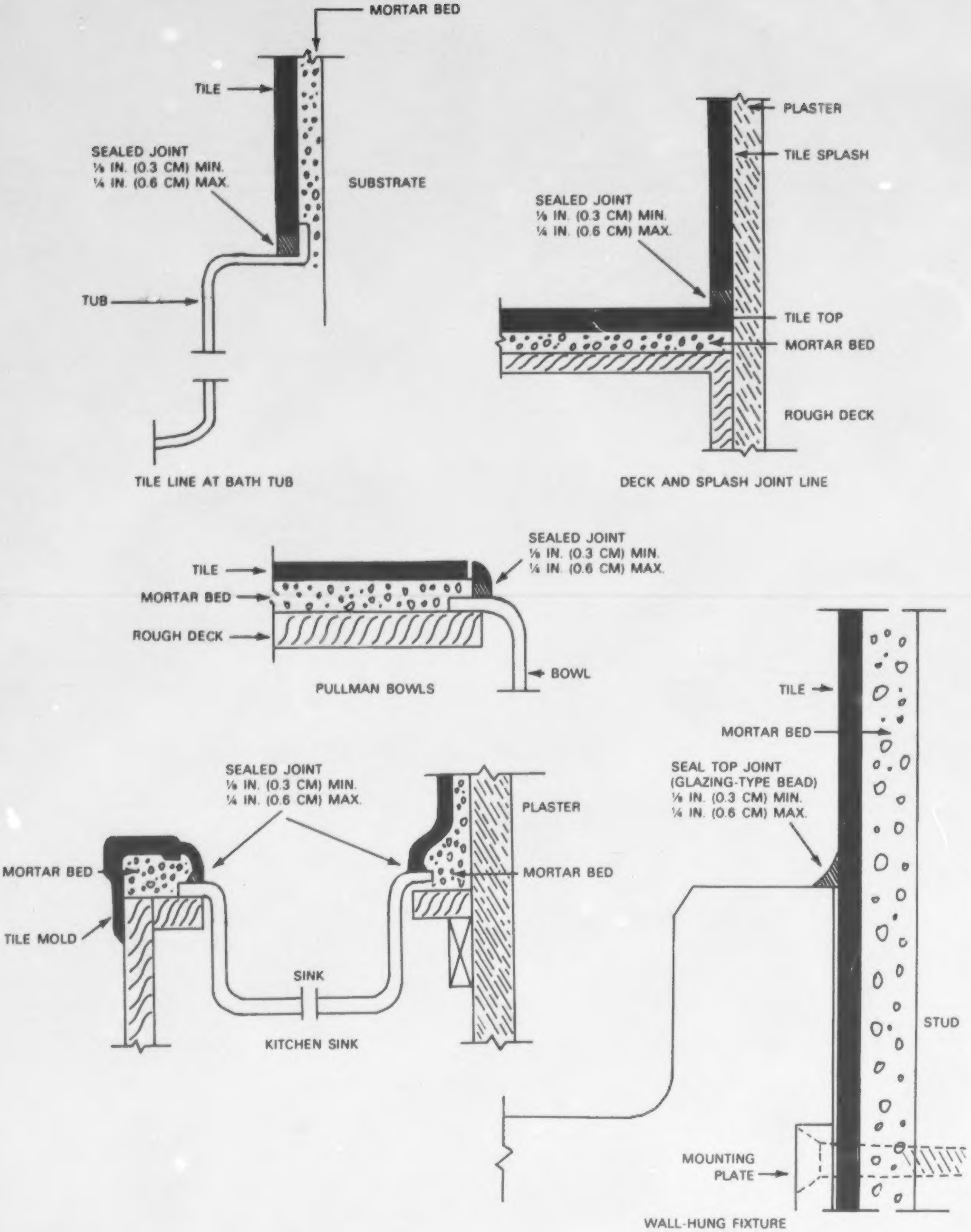

STUDS
METAL LATH
SCRATCH COAT
CONCRETE COLUMN
BACKUP FILLER
SEALANT
TILE
MORTAR BED

Fig. B-77. Butt joint in field of tile (vertical)


MORTAR BED
TILE
SEALED JOINT
⅛ IN. (0.3 CM) MIN.
¼ IN. (0.6 CM) MAX.
SUBSTRATE
TUB
PLASTER
TILE SPLASH
SEALED JOINT
⅛ IN. (0.3 CM) MIN.
¼ IN. (0.6 CM) MAX.
TILE TOP
MORTAR BED
ROUGH DECK
TILE
MORTAR BED
ROUGH DECK
SEALED JOINT
⅛ IN. (0.3 CM) MIN.
¼ IN. (0.6 CM) MAX.
BOWL
TILE
MORTAR BED
SEAL TOP JOINT
(GLAZING-TYPE BEAD)
⅛ IN. (0.3 CM) MIN.
¼ IN. (0.6 CM) MAX.
STUD
MOUNTING PLATE
SEALED JOINT
⅛ IN. (0.3 CM) MIN.
¼ IN. (0.6 CM) MAX.
PLASTER
MORTAR BED
MORTAR BED
TILE MOLD
SINK

TILE LINE AT BATH TUB

DECK AND SPLASH JOINT LINE

PULLMAN BOWLS

KITCHEN SINK

WALL-HUNG FIXTURE

Fig. B-78. Points of application for expansion joints and elastomeric sealants

can absorb all of the physical stresses and can resist chemical attack. The silicones provide the necessary properties to meet the many requirements of such an installation, including a hardness capable of supporting surface traffic.

Failures in Caulking Sealants

Regardless of how well designed the expansion joint may be, its success depends upon the quality of the sealant used. The true function of a caulking compound is to seal out moisture. To maintain this function, the sealant must be an elastomeric type, properly selected and installed to meet the requirements of each installation. The basic problem areas and the recommended solutions are presented in the following paragraphs.

Drying Problem

Oil-based mastics, rubber butyls, and low-grade polysulfides have a tendency to dry out. These types of compounds should never be used if the drying problem is to be avoided. In addition, these materials offer no adhesive qualities. A high-grade elastomeric sealant, such as silicone, is always recommended.

Traffic Damage

Soft caulking will quickly fracture and tear under the abuse of high heels, general foot traffic, and equipment transit. The elastomeric sealant will provide the necessary seal; however, it must have a Shore A hardness of 30 or better. Polyurethanes and silicones provide the necessary properties to meet this requirement for horizontal joints.

Breakage in Center of Sealant Joint

Often referred to as cohesive failure, splitting of the cured sealant through the middle of the joint (parallel to the joint line) is normally the result of the following:

1. The compression set is excessive. The sealant fails to recover during excessive expansion/contraction movement. This problem is eliminated by the use of a sealant that has 90 percent or more compression recovery.
2. The sealant hardens because of aging and the use of excessive fillers in the compound. Accelerated aging tests have proved that silicones (which do not have fillers) will not harden over a 25-year period.
3. The depth of the joint is not sufficient. In the larger joints (½ by ½ inch [1.3 by 1.3 centimetres] or larger) the sealant is less than ¼ inch (0.6 centimetre) thick. This puts excessive stress on a thin membrane.
4. The sealant bonds to the bottom of large joints. When backup fillers are not used, the sealant might bond to the base of the joint. This would defeat the extension capabilities of a good sealant.

Separation of Sealant from Side of Joint

The separation of sealant from the side of a joint is considered to be an adhesive failure. This failure usually is caused by the following:

1. The surface has not been prepared adequately. All surfaces to be sealed must be thoroughly cleaned and free from oils, dust, dirt, curing compound, and the like. The sealant manufacturer's surface preparation requirements must be met.
2. The depth of the joint is too great. Sealant has been forced to the bottom of the joint. The size of the sealant bead should be half the width of the joint in depth but never greater than ½ inch (1.3 centimetres) nor less than ⅛ inch (0.3 centimetre) in depth.

Extrusion of Sealant from the Joint

When the joint is under compression, the sealant may extrude. This normally is caused by excessive sealant in the joint. Also, the use of incorrect backup filler can cause this problem. Unless the filler can readily compress without affecting the sealant, the filler will negate its usefulness. As stated previously, polyethylene or polyurethane flexible foams are the only acceptable backup fillers that will meet all requirements of such expansion joint installations.

TOPIC 10 — EXPANSION JOINTS AND ELASTOMERIC SEALANTS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Expansion joints should be placed 1 to 2 feet on center in exterior tile installations.
   1. ________
   2. ________
2. Working butt joints should be 3 inch minimum and 4 inch maximum.
   3. ________
   4. ________
3. Expansion joints should be placed 5 to 6 feet on center in interior tile installations.
   5. ________
   6. ________
4. When an expansion joint exceeds ½ inch (1.3 centimetres) in depth, a(n) 7 8 is used to support the caulking sealant.
   7. ________
   8. ________
5. Expansion joint sealants for ceramic tilework should not fade, 9 , or 10 .
   9. ________
   10. ________
6. Expansion joints in tilework should extend in depth to the last 11 .
   11. ________
7. Expansion joints in tilework should not extend through the 12 paper, but they should extend through and separate the metal lath and scratch coat.
   12. ________
8. The sealant bead should be 13 the width of the joint in depth.
   13. ________
9. Polyurethanes normally are used for 14 expansion joints.
   14. ________
10. Silicone sealants have 15 surfaces.
    15. ________

Unit C
Blueprints and Specifications

TOPIC 1 — BLUEPRINTS

This topic is planned to provide answers to the following questions:

- **What information does the tilesetter obtain from the blueprints?**
- **How are blueprints made?**
- **What is the "language of blueprints"?**

Many individuals and groups of individuals cooperate to bring a new building to completion. The large amount of information needed by the builder must be put into compact, readable form. The architect, in performing this service, uses what might be called the "language of drafting" to make working drawings, plans, or blueprints. The written specifications tell more about some items than can be told conveniently on the drawings.

From a study of the unit on blueprint reading in the *Introduction to Apprenticeship,* the apprentice tilesetter should have a general knowledge of the language of drafting.

The apprentice will need the information in this unit to be able to progress to the remaining two units in this workbook — "Job Processes" and "Specialized Jobs." In addition, the apprentice will also need to know and understand how to construct simple geometric designs, such as rectangles, circles, arches, and domes. Therefore, this unit also contains information on geometric construction.

Tilesetters must know how to compute areas, determine perimeters, and measure distances. The apprentice is referred to the basic mathematics unit that appears in the *Introduction to Apprenticeship* and to the topic on squares and square roots in this unit.

Language of Blueprints

Blueprints and specifications must convey all the information necessary for the construction of the building and for the cost estimates to be made in advance. Whether the plans are for a large office building, for a factory, or for a medium-priced residence, the same "language" is used; therefore, the apprentice tilesetter must begin as soon as possible to gain a thorough mastery of that language.

The apprentice tilesetter must use the blueprints to visualize how the building will look when completed; to determine the size, shape, and location of all parts to be tiled; and to decide the amount of staging necessary to complete the job. Specifications are written statements outlining the kinds, grades, and sizes of tile and other materials to be used; the standards of work quality to be followed; and the time limit for completion of the contracts.

Describing any proposed building by words alone would be impossible. A more efficient method of transmitting ideas has resulted from the development of the art of drafting. Thus, the blueprint draftsperson conveys to the tilesetter how the tile floor should join the corridor floor, how the door jambs should be finished, how the wainscot should be terminated at the plaster line, how the incorners and outcorners are to be treated, and how the window sills and jambs are to be finished. Familiarization with blueprints helps the tilesetter to visualize every bit of information shown on the drawings.

On an architectural drawing some lines are thicker than others; some are solid; and others are broken. Each type of line has a definite meaning. The more common types of lines are shown in Fig. C-1. Other items in the blueprint language, called symbols and conventions, will be studied in subsequent assignments.

Preparation of Blueprints

Formerly, all drawings had to be inked, but today satisfactory blueprints are made by drawing with a comparatively soft pencil directly on tracing paper. Copies of the drawings are prepared by means of a blueprinting machine.

Many copies of each drawing are needed because many different persons use them. As soon as the architect has completed the plans and specifications, they must be made available to contractors and subcontractors for preparation of their bids for a job or their estimates of total cost. One can readily appreciate the complications that would result if the blueprints were not complete or if all sets were not identical.

Building designs must be approved by the city building inspection department and checked for compliance with the building code and zoning ordinances before building permits may be obtained. For this purpose, a set of plans must be filed with the building inspector. This requirement protects the general public and the property owners in the area.

When a loan is necessary, the plans must also be approved by the lending agency. Finally, of course, a complete set of plans and specifications is needed on the job to serve as a guide for the builders.

Study Assignment

Elmer W. Sundberg, *Building Trades Blueprint Reading—Part I, Fundamentals* (Fifth edition, revised). Chicago: American Technical Society, 1972. Read pp. 5—7.

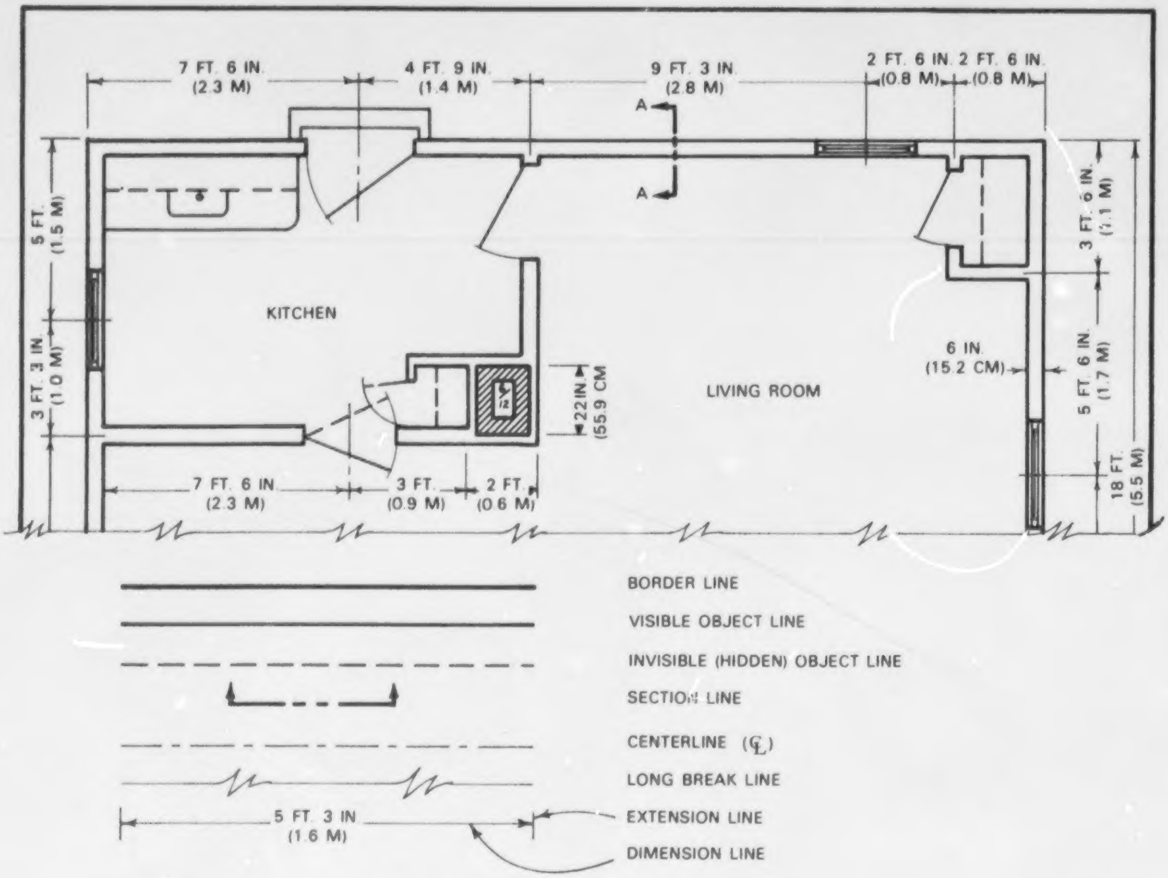

7 FT. 6 IN. (2.3 M)
4 FT. 9 IN. (1.4 M)
9 FT. 3 IN. (2.8 M)
2 FT. 6 IN. (0.8 M)
2 FT. 6 IN. (0.8 M)
A
A
5 FT. (1.5 M)
3 FT. 3 IN. (1.0 M)
KITCHEN
22 IN. (55.9 CM)
LIVING ROOM
6 IN. (15.2 CM)
3 FT. 6 IN. (1.1 M)
5 FT. 6 IN. (1.7 M)
18 FT. (5.5 M)
7 FT. 6 IN. (2.3 M)
3 FT. (0.9 M)
2 FT. (0.6 M)
BORDER LINE
VISIBLE OBJECT LINE
INVISIBLE (HIDDEN) OBJECT LINE
SECTION LINE
CENTERLINE (℄)
LONG BREAK LINE
5 FT. 3 IN (1.6 M)
EXTENSION LINE
DIMENSION LINE

Fig. C-1. Conventional blueprint lines

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 1 — BLUEPRINTS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The "blueprints" on which lines are a brownish color are called 1 prints. 1. ________
2. Most blueprints are made by the 2 process. 2. ________
3. Special features of a tiled fireplace mantel would be shown on a(n) 3 drawing. 3. ________
4. A blueprint with blue lines on a white background requires a(n) 4 5 . 4. ________ 5. ________
5. Conventional blueprints are made on paper 6 with iron salts. 6. ________
6. Complete directions for the construction of a building are obtained from the 7 and 8 . 7. ________ 8. ________
7. A(n) 9 draws the building plans, and a(n) 10 submits bids for the job. 9. ________ 10. ________
8. The heaviest pencil line on the sheet is the 11 line, and next to it in thickness is the visible 12 line. 11. ________ 12. ________
9. Objects that are invisible to the eye are shown by means of a(n) 13 line. 13. ________
10. Specifications contain information concerning kinds of 14 , 15 of work quality, and completion date. 14. ________ 15. ________

TOPIC 2 — PLAN VIEWS

This topic is planned to provide answers to the following questions:

- **What is a plan view?**
- **How does the tilesetter use floor plans?**
- **How are different materials represented on blueprints?**

The ability to know in which direction to look or to discover in which direction the draftsperson was looking when he or she drew the building plans is the key to all blueprint reading. A blueprint in which the reader is "mentally" looking down on a building is known as a plan view. Plot plans, foundation plans, roof plans, and floor plans are all plan views. In this assignment the main consideration is given to floor plans, which are extremely important because of the large amount of information that must be obtained from them.

Study Assignment

Sundberg, *Building Trades Blueprint Reading—Part I, Fundamentals* (Fifth edition, revised), 1972.

1. Read pp. 31—39, "Reading Floor Plans."
2. Answer Self-Check Quiz No. 4, p. 39.
3. Read pp. 43—58, "Symbols and Notations." Answer Self-Check Quiz No. 5-B, p. 53; Quiz No. 5-C, p. 55; Quiz No. 5-D, p. 57; and Quiz No. 5-E, p. 59.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 2 — PLAN VIEWS

Study Guide

Answer the questions in Trade Competency Test No. 3, pp. 41 and 42; and Test No. 4, pp. 60—62 in the assigned reference.

TOPIC 3 — ELEVATION VIEWS

This topic is planned to provide answers to the following questions:

- **What are elevation views?**
- **What are the elevation symbols?**
- **How does the tilesetter use elevation drawings?**

The elevations are plans that are drawn as if the draftsperson were on the same level as the building and were drawing it from in front, in back, or one side. Elevation views show the size and shape of the exterior of the building and the details of exterior finish. Although much of this information can also be found in the specifications, the tilesetter will find it difficult to visualize the completed tilework without elevation drawings. A study of this assignment should help the tilesetter to understand how elevations are drawn and what they represent.

Although the symbols and conventions used on elevation drawings are not completely standardized, good designers always remove any chance of misunderstanding by carefully noting and following the explanatory notes on the plans.

Study Assignment

Sundberg, *Building Trades Blueprint Reading—Part I, Fundamentals* (Fifth edition, revised), 1972.

1. Read pp. 17—28, "Reading Elevation Drawings."
2. Answer Self-Check Quiz No. 3-A, p. 20; Quiz No. 3-B, p. 24; and Quiz No. 3-C, p. 26.
3. Study the elevation symbols on p. 45.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 3 — ELEVATION VIEWS

Study Guide

Answer the questions in Trade Competency Test No. 2, pp. 28—30, in the assigned reference.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 4 — STRUCTURAL DETAILS

This topic is planned to provide answers to the following questions:

- **What information does the tilesetter obtain from the structural details?**
- **Where does the tilesetter find the tilework details?**

The structural details provide the specific information the tilesetter will need for estimating costs, ordering materials, and setting the tile. Plan and elevation views do not provide sufficient details. A set of blueprints usually includes large-scale drawings of those parts that are not shown clearly in the small-scale elevation and floor plans.

Mirrors, tile caps, tile shelves, tile bases, and other special construction features require details. For instance, details of a tile and finish floor in a commercial building would show a finish floor on concrete and a tile floor on 2 inches (5.1 centimetres) of mortar. Gutter details of a swimming pool would show the layout of the nonslip ceramic mosaic and the ceramic bead, if they are the materials used, on the surface of the mortar setting bed and the metal lath and reinforcing bars next to the rough concrete.

Details usually are printed on the same sheet with the elevation or floor plan. Otherwise, the note "See Detail" is shown on the drawing, and the details are shown on another sheet. These details are usually interior elevation views or cutaway drawings. For example, the floor plan of a bathroom that has tile walls and tile floors would not show tile details because the tiling of the walls would be very difficult to describe in the notes on the plan. Details of the four tile walls would be described in four elevation drawings of the walls.

Study Assignment

Sundberg, *Building Trades Blueprint Reading—Part I, Fundamentals* (Fifth edition, revised), 1972. Read pp. 77—86, "Reading Blueprints for Structural Information"; and pp. 89—99, "Reading Detail Drawings."

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 4 — STRUCTURAL DETAILS

Study Guide

Answer the questions in Trade Competency Test No. 6, pp. 86—88; and Test No. 7, pp. 100—102, in the assigned reference.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 5 — GEOMETRICAL CONSTRUCTION

This topic is planned to provide answers to the following questions:

- **Why is geometry important to the tilesetter?**
- **How are the different tile configurations laid out?**
- **How are polygons constructed?**

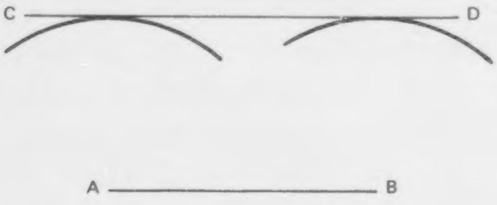
In making layouts and designs, the tilesetter sometimes needs to be more accurate than freehand sketching will allow. For this more accurate geometrical construction, the following tools are needed: a good straightedge, a compass, and a protractor. The tilesetter can use these tools to construct parallel, perpendicular, and tangent lines; divide straight and curved lines; bisect angles; and construct triangles, circles, and polygons of almost any description.

The construction of several geometrical forms is illustrated below and on the following pages.

Drawing Parallel Lines

Parallel lines are lines extending in the same direction, and they are the same distance apart throughout their length. Parallel lines can be constructed as follows:

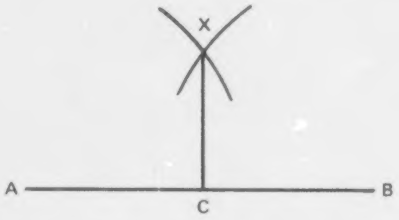
1. Draw a line (AB).
2. Set the compass at the distance the lines will be apart.
3. Place the point of the compass on the line near one of its ends, and swing an arc.
4. Repeat step 3 near the other end of the line.
5. Draw a line touching the top of both arcs (CD); this line is parallel to the first line.



Drawing Perpendicular Lines

Two lines are perpendicular to each other when their intersection forms a right angle. Perpendicular lines can be drawn as follows:

1. Swing equal arcs from point C to the line AB.
2. Increase the radius, and swing equal arcs from each of the points of intersection of the first arcs.
3. From the point of intersection of the last two arcs (point X), draw a line that intersects AB at C; this line is perpendicular to AB.

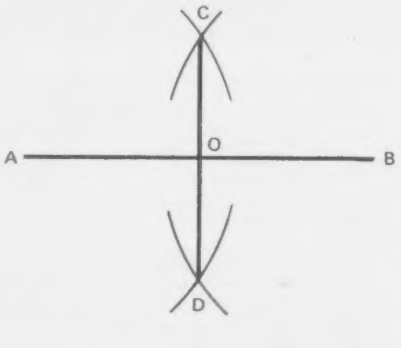


A vertical line is a plumb line and is the same as a line perpendicular to a true horizontal line. It is formed in the same way as a perpendicular line.

Bisecting Lines

A line can be bisected as follows:

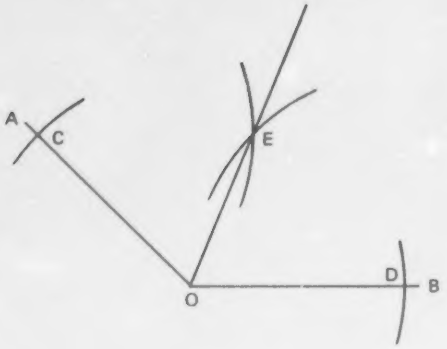
1. To bisect line AB, use a radius greater than one-half AB and strike arcs from A and B intersecting at C and D.
2. Connect C and D with a line. Point O will be the center of AB.

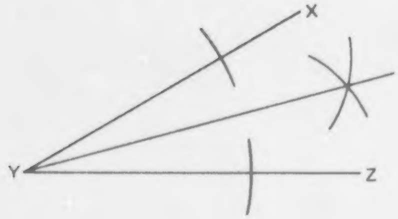


Bisecting Angles

An angle can be bisected as follows:

1. Using O as center, strike equal arcs on AO and OB at C and D.
2. Strike equal arcs from C and D intersecting at E.
3. Connect E and O. This line will bisect angle O. This procedure may be used to bisect any size angle, as XYZ.

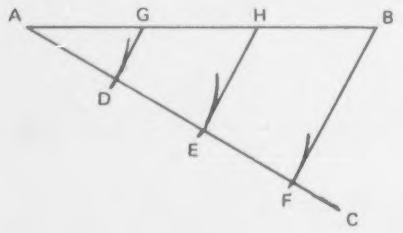




Dividing a Line into Equal Parts

A line can be divided into equal parts as follows:

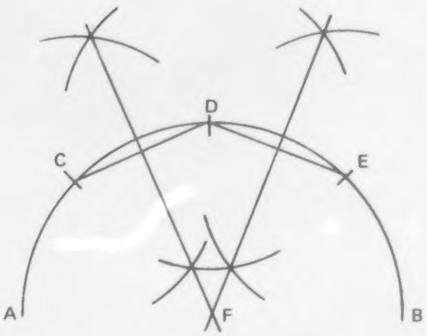
1. From point A, draw line AC at an angle to AB.
2. Mark off on AC the desired number of spaces, using the same arc for striking each.
3. Connect points F and B.
4. Construct lines DG and EH parallel to FB. Thus, AG, GH, and HB will be equal parts of AB.



Finding the Radius of an Arc

The radius of an arc can be established as follows:

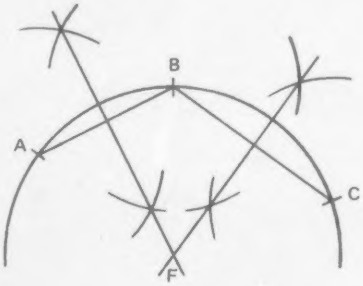
1. On the arc AB establish points C, D, and E at equal distances from each other.
2. Draw lines CD and DE.
3. Find the exact centers of lines CD and DE.
4. Extend these center lines to where they intersect at F. FA, FC, FD, FE, and FB will all be the same distance and will be the radius of arc AB.



Finding an Arc

An arc can be formed around three points as follows:

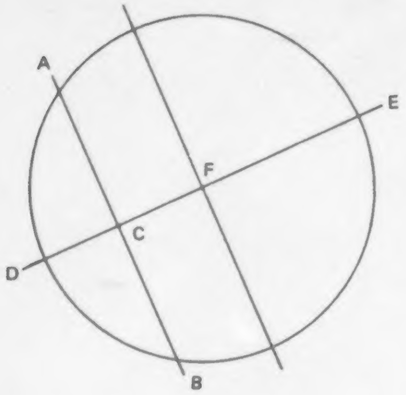
1. Draw lines AB and BC
2. Find the centers of AB and BC, and extend these center lines to intersect at F.
3. Using FA as the radius and F as center, draw the arc ABC.



Centering a Circle

A circle can be centered as follows:

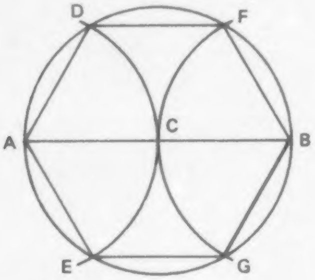
1. Draw a straight line through two parts of a circle, as AB.
2. Locate center of this line, as C.
3. Draw line perpendicular to AB through point C so as to intersect opposite sides of circle at D and E.
4. Find center of DE. Center of line DE (point F) is center of the circle.



Laying Out a Hexagon

A hexagon can be drawn as follows:

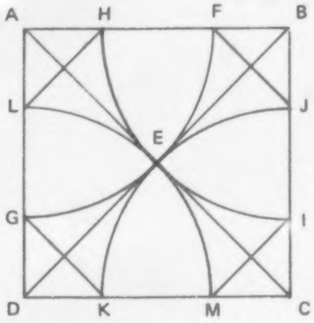
1. Draw AB to represent diameter of hexagon.
2. Locate C as center of AB, and draw circle using C as center and AC as radius.
3. Using AC as radius and A and B as centers, inscribe arcs DE and FG.
4. Connect points A, D, F, B, G, and E.



Laying Out an Octagon

An octagon can be drawn as follows:

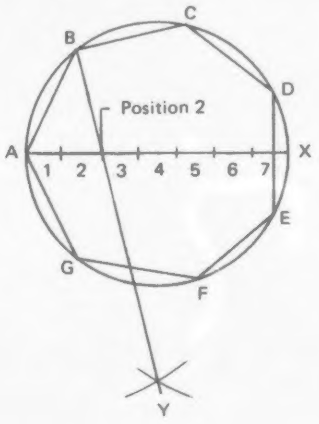
1. Draw square ABCD to required dimensions.
2. Connect opposite points with diagonal lines.
3. Using AE as radius and A, B, C, and D as centers, inscribe arcs FG, HI, JK, and LM.
4. Connect points L and H, F and J, I and M, and G and K.



Laying Out a Polygon

The progressive steps to lay out a polygon with seven sides (heptagon) are shown in the accompanying illustration. A polygon with any number of sides can be drawn as follows:

1. Draw circle to required diameter.
2. Using the diameter as a radius and A and X as centers, draw intersecting arcs at Y.
3. Divide the diameter into the same number of parts as the number of sides in the polygon. (The number seven is used in the illustration.)
4. Connect the intersecting arcs at Y with position 2 on the diameter, and extend the line to intersect the circumference. Always use position 2 irrespective of the number of sides.
5. Set dividers to AB, and step off circumference into seven parts, as at C, D, E, F, and G.
6. Connect all points on the circumference.



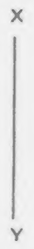
UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 5 — GEOMETRICAL CONSTRUCTION

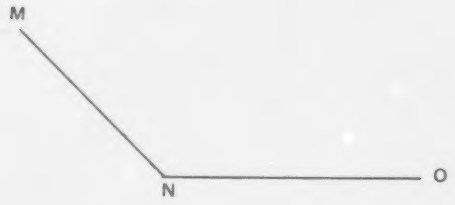
Study Guide

Complete the following exercises:

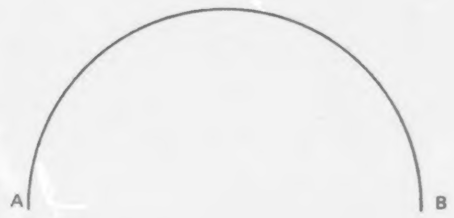
1. Draw a line parallel to XY.



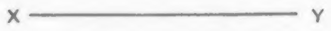
2. Bisect angle MNO.



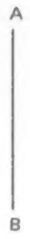
3. Find the radius of arc AB.



4. Using XY as its diameter, lay out a hexagon.



5. Bisect line AB.



UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 6 — SQUARES AND SQUARE ROOTS

This topic is planned to provide answers to the following questions:

- **Why does the tilesetter have to learn to square numbers and find square roots?**
- **What materials are available to help the apprentice learn squares and square roots?**

Most of the mathematics needed by the tilesetter has been covered in the *Introduction to Apprenticeship*. In addition, the tilesetter must understand how to square numbers and how to find square roots.

These things are particularly important in determining the hypotenuse of a right triangle for tile layouts (Fig. C-2). The tilesetter who understands squares and square roots will be able to use the formula $C = \sqrt{A^2 + B^2}$ to arrive at the correct answer, which in the example is 10 ($C = \sqrt{6^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100} = 10$).

The assigned references will give information both on squaring numbers and on finding square roots.

Study Assignment

Glen M. Hobbs and James McKinney. *Practical Mathematics* (Third edition). Chicago: American Technical Society, 1973. Read pp. 249—66 and 379—418; or Pamphlet No. 8, "Powers and Roots," and Pamphlet No. 12, "Lengths and Areas," pp. 12—16.

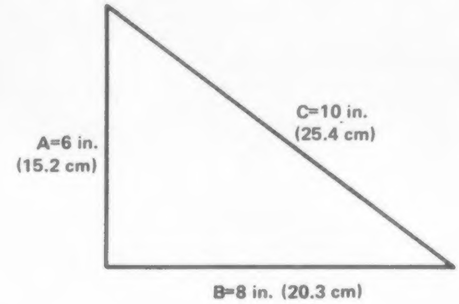


Fig. C-2. Right triangle

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 6 — SQUARES AND SQUARE ROOTS

Study Guide

Solve the following problems in squares and square roots:

1. $\sqrt{11}$ = 1. ________

2. $\sqrt{68{,}644}$ = 2. ________

3. $\sqrt{9{,}409}$ = 3. ________

4. $\sqrt{7{,}921}$ = 4. ________

5. $\sqrt{625}$ = 5. ________

6. 47^2 = 6. ________

7. $(^3/_{16})^2$ = 7. ________

8. $(55^1/_3)^2$ = 8. ________

9. $(15 \text{ ft. } 3 \text{ in.})^2$ = 9. ________

10. $(4 \text{ in.})^2$ = 10. ________

TOPIC 7 — SPECIFICATIONS AND CONTRACTS

This topic is planned to provide answers to the following questions:

- **How are the specifications used by the tilesetter?**
- **Who is responsible for writing the specifications?**
- **What conditions are covered in the contract?**

Building plans and specifications provide an equal basis on which all contractors can bid on the same job. Specifications supplement the plans, because details such as serial numbers, model numbers, textures, finishes, and qualities are too numerous to be included on the plans. Requirements in greater detail can be set forth for the entire job in the specifications.

Specifications

The plans and specifications provide a neutral ground for settling disputes between the contractor and client. They establish a legal basis for supplemental authorizations, for division of responsibility, and for other relationships. The specifications indicate responsibilities in regard to performance and completion dates for all subcontractors. Specifications must be prepared for any job where loan commitments are anticipated.

On major building projects, specifications are studied and contracts negotiated by attorneys. The contract frequently involve complicated legal operations. Thousands of dollars may be expended before a contract finally can be signed. In residential construction, specifications are still legal and binding, but they are not as complex. Every house should have specifications, which usually are required by city or county building departments. The plans and specifications should be available at the construction site. When a loan commitment is desired, seven sets of plans and specifications usually are needed. Additional copies are needed for the bidding process and for other purposes.

Contracts

Certain conditions that govern contracts are customarily accepted and observed on all building projects. The contract covers such particulars as insurance; responsibility for provision of facilities on the job; and relationships of the owner, architect, contractor, and subcontractors.

A basic understanding of the contractor's responsibilities is important if the journey-level tilesetter is to complete the tilework effectively. On many building projects, the tilesetting contract is awarded to a tilesetting company by the general contractor as a subcontract. However, whether this is true or whether the tilesetting contract is awarded directly by the architect, the form and content of the specifications will be the same. Because the quality of the materials and the extent of the work required are fairly similar from one contract to another, the journey-level tilesetter becomes familiar with the usual requirements. To understand the exceptions or to recognize when a material or a procedure is not normal and therefore may be incorrect, the apprentice must gain a basic knowledge of the standard specifications upon which individual plans are based.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 7 — SPECIFICATIONS AND CONTRACTS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Specifications usually are required by city or county __1__ departments. 1. ________

2. Specifications indicate responsibilities in regard to performance and __2__ dates for all subcontractors. 2. ________

3. The plans and specifications should always be __3__ on the job. 3. ________

4. Specifications are required for any job where __4__ commitments are anticipated. 4. ________

5. The tilesetting contract often is awarded by the general contractor as a(n) __5__. 5. ________

TOPIC 8 — MATERIAL ESTIMATING

This topic is planned to provide answers to the following questions:

- **Who is responsible for estimating material for a job?**
- **What are the methods of estimating material?**
- **How are blueprints scaled by the tilesetter?**

Before the tilesetter can begin a job, the correct quantity of material must be available in the working area. To avoid purchasing too much or too little tile, the tile contractor must make an estimate of the quantity needed. To have too much material on hand is expensive, because storage space must be found or unnecessary drayage paid. To have too little material on hand causes delays and often requires a layoff by the contractor.

An employer chooses the supervisor from among those journey-level workers who have a thorough knowledge of blueprint reading and material estimating. This does not mean the tilesetter should have the ability to estimate all the material needed, for example, for a three-story building. But the employer does expect the supervisor to estimate the amount of material needed to complete a specific tile job before the original supply of material is exhausted. The tilesetter who can do these things will gain a reputation for being efficient and will have a better chance of advancing to a supervisory position.

Bases for Material Estimating

To estimate the material needed on a tilesetting job, the tilesetter generally checks the specifications, the room schedule on the blueprints, and the details on the blueprints. The tilesetter then scales the prints.

Specifications

The tilesetter checks the specifications for the following:

1. Type of floor
2. Type of base
3. Size of tile
4. Strips for inserts, if any
5. Type of cap
6. Accessories
7. Type of installation: mortar (set with scratch coat and float coat); thin-set mortar; or organic adhesives
8. Special materials

Room Schedule

The room schedule on the blueprint is checked by the tilesetter for the following:

1. Rooms that have tile
2. Height of the wainscot
3. Trims in the rooms (trims around openings, if any)
4. Type of threshold

Details

The tilesetter checks the details on the blueprint for the following:

1. Reinforcing mesh
2. Waterproofing membrane
3. Thickness of mortar setting bed

Print Scaling

Prints are scaled by the tilesetter for the quantity of tile and other materials needed for the job. The tilesetter also establishes a procedure to be followed so as to eliminate possible errors. For example, the tilesetter always starts at one point and follows through until he or she has returned to the original point. By knowing the total length of the walls of a room, he or she can determine the quantity of caps, bases, strips, and wall tile needed. The tilesetter also can determine the quantity of tile needed for the floor area.

Methods of Material Estimating

The tilesetter should have at least a basic understanding of how the material estimate for tilesetting is made. Several easy methods of estimating have been developed to help the tilesetter determine the amount of material needed for a given job.

Floors

The surface area of a floor is determined by multiplying the length by the width. For example:

Floor length = 15 ft. (4.5 m)
Floor width = 16 ft. (4.8 m)
Floor area = 15 ft. × 16 ft. = 240 ft.^{2} (4.5 m × 4.8 m = 21.6 m^2) (In this publication ft.^{2} = sq. ft., in.^{3} = cu. in., and so forth.)

Walls

The surface area of a wall is determined by multiplying the length by the height. The area of any openings is subtracted from the total wall area. For example:

Wall length = 56 ft. (16.8 m)
Wall height = 8½ ft. (2.6 m)
Door = 7 ft. × 3 ft. (2.1 m × 0.9 m)

98

Wall area = 56 ft. × 8½ ft. = 476 ft.^{2} (16.8 m × 2.6 m = 43.7 m^2)
Door = 21 ft.^{2} (1.9 m^2)
Total area = 476 ft.^{2} − 21 ft.^{2} = 455 ft.^{2} (43.7 m^2 − 1.9 m^2 = 41.8 m^2)

Ceilings

The surface area of a ceiling is determined by multiplying the length by the width. For example:

Ceiling length = 15 ft. (4.5 m)
Ceiling width = 20 ft. (6 m)
Ceiling area = 15 ft. × 20 ft. = 300 ft.^{2} (4.5 m × 6 m = 27 m^2)

Trims

The quantity of trims (cap and base) in linear feet is determined by subtracting the length of the openings from the perimeter of the wall or walls. For example:

Room length = 15 ft. (4.5 m)
Room width = 14½ ft. (4.4 m)
Trim length = 15 ft. + 15 ft. + 14½ ft. + 14½ ft. = 59 ft. (4.5 m + 4.5 m + 4.4 m + 4.4 m = 17.8 m)
Opening length = 4 ft. (1.2 m)
Trim needed = 59 ft. − 4 ft. = 55 ft.(17.8 m − 1.2 m = 16.6 m)

Base Material

The quantity of sand needed for the base material to be used in a room is determined by dividing the total area of the wall, floor, and ceiling by 12. This will give the amount of sand needed for a mortar bed that is 1 inch (2.5 cm) thick. For example:

Length of room = 15 ft. (4.5 m)
Width of room = 15 ft. (4.5 m)
Wall height = 8 ft. (2.4 m)
Wall area = 8 ft. × 15 ft. × 4 = 480 ft.^{2} (2.4 m × 4.5 m × 4 = 43.2 m^2)
Door area = 4 ft. × 6 ft. = 24 ft.^{2} (1.2 m × 1.8 m = 2.2 m^2)
Wall area to be tiled = 480 ft.^{2} − 24 ft^2 = 456 ft.^{2} (43.2 m^2 − 2.2 m^2 = 41 m^2)
Ceiling area = 15 ft. × 15 ft. = 225 ft.^{2} (4.5 m × 4.5 m = 20.3 m^2)
Floor area = 15 ft. × 15 ft. = 225 ft.^{2} (4.5 m × 4.5 m = 20.3 m^2)
Sand needed =

$$\frac{456\text{ ft.}^2 + 225\text{ ft.}^2 + 225\text{ ft.}^2}{12} = 75\tfrac{1}{2}\text{ ft.}^3\ (2.1\text{ m}^3)$$

Because sand comes in cubic yards, the volume in cubic feet of sand should be divided by 27 to determine the number of cubic yards.

$$\frac{75\tfrac{1}{2}\text{ ft.}^3}{27} = 2.8\text{ yd.}^3\ (2.1\text{ m}^3)$$

The quantity of cement needed on this job when cement is mixed at a ratio of one part cement to 4½ parts sand is found by dividing the volume of sand, in cubic feet, by 4½. (One sack of cement = 1 ft.^{3} or 0.03 m^3)

$$\frac{75\tfrac{1}{2}\text{ ft.}^3}{4\tfrac{1}{2}} = 16.8\text{ ft.}^3\ (0.5\text{ m}^3)$$

The quantity of lime needed for the walls and ceilings when lime is mixed at a ratio of one part lime to six parts sand is found by dividing the volume of sand (in cubic feet) by 6. (One sack of lime = 1 ft.^{3} or 0.03 m^3)

$$\frac{56\text{ ft.}^3}{6} = 9.3\text{ ft.}^3\ (0.3\text{ m}^3)$$

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 8 — MATERIAL ESTIMATING

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. One sack of cement is equal to __ 1 __ cu. ft.
   1. ________

2. To determine the quantity of trims, in linear feet, subtract the openings, if any, from the __ 2 __ of the __ 3 __.
   2. ________
   3. ________

3. To determine the surface area of a floor, in square feet, __ 4 __ the length by the __ 5 __.
   4. ________
   5. ________

4. The tilesetter checks the __ 6 __ on the blueprint for the thickness of the mortar setting bed.
   6. ________

5. To determine the number of cubic yards of sand needed on a tile job, divide the number of __ 7 __ __ 8 __ of sand by __ 9 __.
   7. ________
   8. ________
   9. ________

6. The tilesetter checks the __ 10 __ to determine who is responsible for setting the accessories.
   10. ________

7. Prints are __ 11 __ by the tilesetter for the quantity of tile needed for a job.
   11. ________

8. The tilesetter should check the __ 12 __ __ 13 __ for the height of the wainscot.
   12. ________
   13. ________

9. To determine the type of cap and the size of tile, the tilesetter checks the __ 14 __.
   14. ________

10. One sack of lime is equal to __ 15 __ cu. ft.
   15. ________

TOPIC 9 — LARGE COMMERCIAL PROJECTS

This topic is planned to provide answers to the following questions:

- **How does the tilesetter locate details on large blueprints?**
- **What is a room finish schedule?**
- **What does the tilesetter learn from elevation drawings?**

In the topics studied thus far, the apprentice tilesetter has worked only with blueprints for an average-size house. Being able to work with blueprints of this size is by no means sufficient today, as the new high-rise construction in progress all over the country clearly shows. The job of designing and drawing blueprints for these buildings is sometimes so gigantic it must be handled by several architectural firms combined.

The apprentice might be asked by a supervisor to find a window or wainscot detail of a rest room located in the southwest corner of the tenth floor of such a building. Without some idea of how to look for the correct sheet that contains this information, an individual would have to make a time-consuming search.

A competent supervisor, estimator, or tilesetter should be able to find the information needed to complete the job efficiently. A small oversight could mean the difference between a profit and a loss. The job layout and material estimates are figured from the blueprints. A bid for the job usually is submitted before the site is cleared for construction.

General Procedure

No set rules or methods have been established for working with large blueprints. The symbols, lettering, dimensioning, and arrangement of sheets vary with each architect or architectural firm. Therefore, the following information is given to serve as a guide to the apprentice tilesetter who must, for the first time, work with a stack of blueprints for a large commercial building.

Step One

The tilesetter first studies the title page or, as it is sometimes called, the sheet index or schedule of drawings. The major divisions into which the blueprints are divided, such as plumbing, architectural, structural, and architectural plot plans, are shown in the lower right-hand corner near the title block. Generally, tilework is found in the architectural division. The sheet index also may contain the schedule of abbreviations and symbols used in that particular set of blueprints.

Step Two

The room finish schedule must be located. It usually is located on the title page. The room finish schedule is most important because it describes the finish of the floors, walls, and ceilings of every room in the building. It is particularly important to the tilesetter because from it he or she learns where the tile is to be installed. The floor, trim, and wainscot should be checked for tilework requirements. The room finish schedule may also list the sheet numbers of the plans for each room.

Step Three

The third step is locating the sheet that gives the floor plan of the room in question. The floor plans, which were described in Topic 2 of this unit, give information on the size, shape, wall construction, and floor construction. A section is used to illustrate the wall construction and type of tile. A detail notation, such as that in Fig. C-3(a), may be given. In such a symbol the top number indicates the appropriate detail, and the lower number gives the sheet on which it may be found.

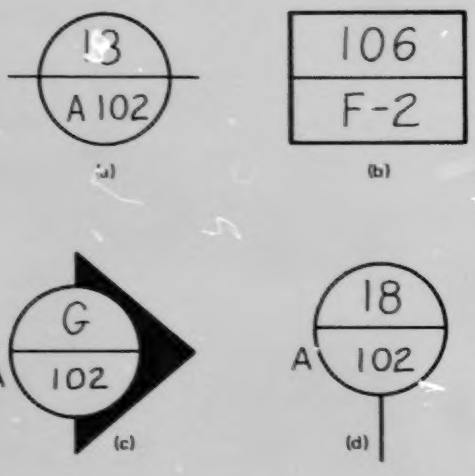


Fig. C-3. Symbols used on the blueprints for a large project

Step Four

The tilesetter needs to study the interior elevations. These drawings show the vertical and horizontal dimensions and illustrate how the finished installation will look. Here again, a detail may be used. The details and sections of a large building might require several sheets.

Finding One Detail

No general rules can be given that will apply to every set of blueprints. Each set should be given careful and methodical study. The following example illustrates the kind of searching a tilesetter may have to do to answer a question on a job. It is presented through the cooperation of the Los Angeles architectural firm of Balch-Hutchason-Perkins. The plans involved were for the Center Intermediate School in Azusa.

The question posed to the tile supervisor on this job was, "What is to be the total height of the tile wainscot in the girls' and boys' showers?"

To answer this question, the supervisor needed to read the height shown in the architectural details. Later, he would also need to check the measurements of the actual pieces of tile specified for this job. But before he was able to locate the architectural details, he had to go through the following procedure:

The supervisor first located the name or number of the building housing the showers. To do this, he looked at the index of drawings on sheet AP-1. This led him to the site plan, also on sheet AP-1. Here he found the legend of the buildings and learned that the building he wanted was "J."

The supervisor then needed the floor plan for building J. He again referred to the index of drawings, which revealed that sheets A101 and A201 contained the floor plans. (He also discovered that these same sheets showed the exterior elevations and room finish schedules.)

When he turned to the floor plan, the tile supervisor saw the layout of the rooms, the room numbers, the slope of the floor, and the location of the floor drains.

From the room finish schedule, the supervisor saw that two types of finishes were to be used in the shower rooms. Finish F-1 was to be colored nonslip cement and portland cement plaster with no ceramic tile. Finish F-2 was to be ceramic tile. Under this finish was the symbol shown in Fig. C-3(a), which meant that more information on the finish in this room was to be found in detail 18 on sheet A102.

Further inspection of the floor plan disclosed that both rooms 106 and 108 on page A101—the girls' and boys' showers—were to have tile. This was indicated by the symbol reproduced in Fig. C-3(b). In this symbol the top number is the room number, and the lower number is the room finish schedule number.

The supervisor also noted the symbol shown in Fig. C-3(c). The symbol was pointing to the south wall. The "G" at the top indicated what detail to look for on the interior elevation, and the number represented the sheet on which it would be found.

The next sheet to be studied was A102, which contained the interior elevations. When the tile supervisor studied detail "G" on the interior elevations, he found the symbol illustrated in Fig. C-3(d). The top number was that of the detail needed, and the lower number was that of the sheet on which it would be found.

Finally, the supervisor had to locate the details. In detail 18 he found that the tile wainscot was to be 6 feet 6 inches (2 metres) high. The detail showed that a bullnose was to go at the top of the wainscot and that a shoe base was to go at the bottom. The detail also gave the overall thickness of the mortar bed and tile for both the walls and floor.

By checking further on the sheet of details, the supervisor found instructions on how other tile installations were to be made. One detail showed how the shower partitions were to be constructed. Another detail indicated that the bullnose on the top was to be laid flat. Another showed how the shower curb was to be built. This detail also showed that the curb top was to be trimmed with a 6 by 6 inch (15.2 by 15.2 centimetre) double bullnose.

Summary

The procedures for finding a detail in a set of plans can be summarized as follows:

1. Locate the floor on which tile is to be installed.
2. Find the floor plan for that particular floor and room layout.
3. Locate the interior elevations for that portion of the construction.
4. Obtain the correct detail from the interior elevations.

UNIT C — BLUEPRINTS AND SPECIFICATIONS

TOPIC 9 — LARGE COMMERCIAL PROJECTS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Tilework is usually included on a set of plans under 1 division.
   1. ________

2. A(n) 2 for a construction job is usually submitted before the construction site has been cleared.
   2. ________

3. The room finish schedule describes the finish of the walls, floors, and 3 of every room in the building.
   3. ________

4. The symbol generally used for a detail notation indicates both the 4 of the detail itself and the sheet of blueprints on which it is to be found.
   4. ________

5. Information on the slope of the floor for a shower room would be found on the 5 6 .
   5. ________
   6. ________

6. While studying the room finish schedule, the tilesetter should check in particular the information on floors, 7 , and 8 .
   7. ________
   8. ________

7. After locating on the architectural details the information needed for tile installation, the tilesetter should also 9 the tile itself.
   9. ________

8. The schedule of abbreviations and 10 used on a set of blueprints is often included on the title page.
   10. ________

9. The title page of a set of plans is also sometimes called a schedule of drawings or 11 12 .
   11. ________
   12. ________

10. The tilesetter should study the 13 14 15 to determine whether a wall is to have a plaster or tile finish.
    13. ________
    14. ________
    15. ________

Unit D
Job Processes

TOPIC 1 — TILE LAYOUT

This topic is planned to provide answers to the following questions:

- **How important is a good tile layout?**
- **How are tile layouts planned?**
- **How are showers squared?**
- **What is a diagonal layout?**

More than any other job process, the layout of the tile can enhance the beauty of a building. Any errors in layout are so readily apparent that apprentice tilesetters must master the technique if they are to succeed in the trade. A good layout will make the actual application of tiles easier, whereas a poor or indifferent layout slows the work process.

Centering Tile on Walls

To center tile in a course on a vertical surface (Fig. D-1), the tilesetter must first determine the number of tiles required to fill the course. The pattern must be centered exactly on the area to be covered. If this layout results in an even number of full-size tiles and cuts, the centerline of the course is on a joint, and the course may come out with less than half a tile at each end. Shifting one of the middle tiles from the joint to the center of the tile course will result in end cuts of half a tile plus the cut. For example, if 4¼-inch (10.8-centimetre) tiles are used and the pattern results in 1½-inch (3.8-centimetre) cuts on each end of the wall, shifting the center tile by half a tile will give cuts at

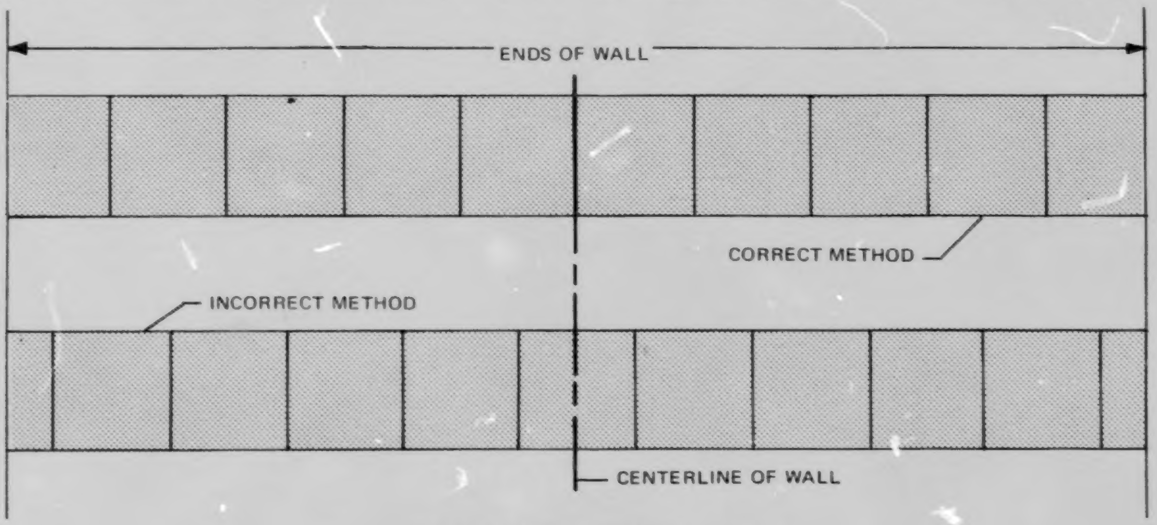


Fig. D-1. Tiles centered on wall

each end of the wall of 2⅛ inches (5.4 centimetres) plus 1½ inches (3.8 centimetres) or 3⅝ inches (9.2 centimetres).

When tilesetters are working with decorative tile that has a continuous pattern, they should continue to set tile on the adjoining wall with the piece cut off from the previous wall; otherwise, the pattern will not match. Also, when working on two walls that run from an outcorner, the tilesetters should begin at the outcorner with full-size tiles and proceed to the ends of the walls unless the tile at the opposite end of the course proves to be less than half a tile. In that case the situation should be handled like any other centering problem, as outlined in the preceding paragraph.

Squaring a Shower

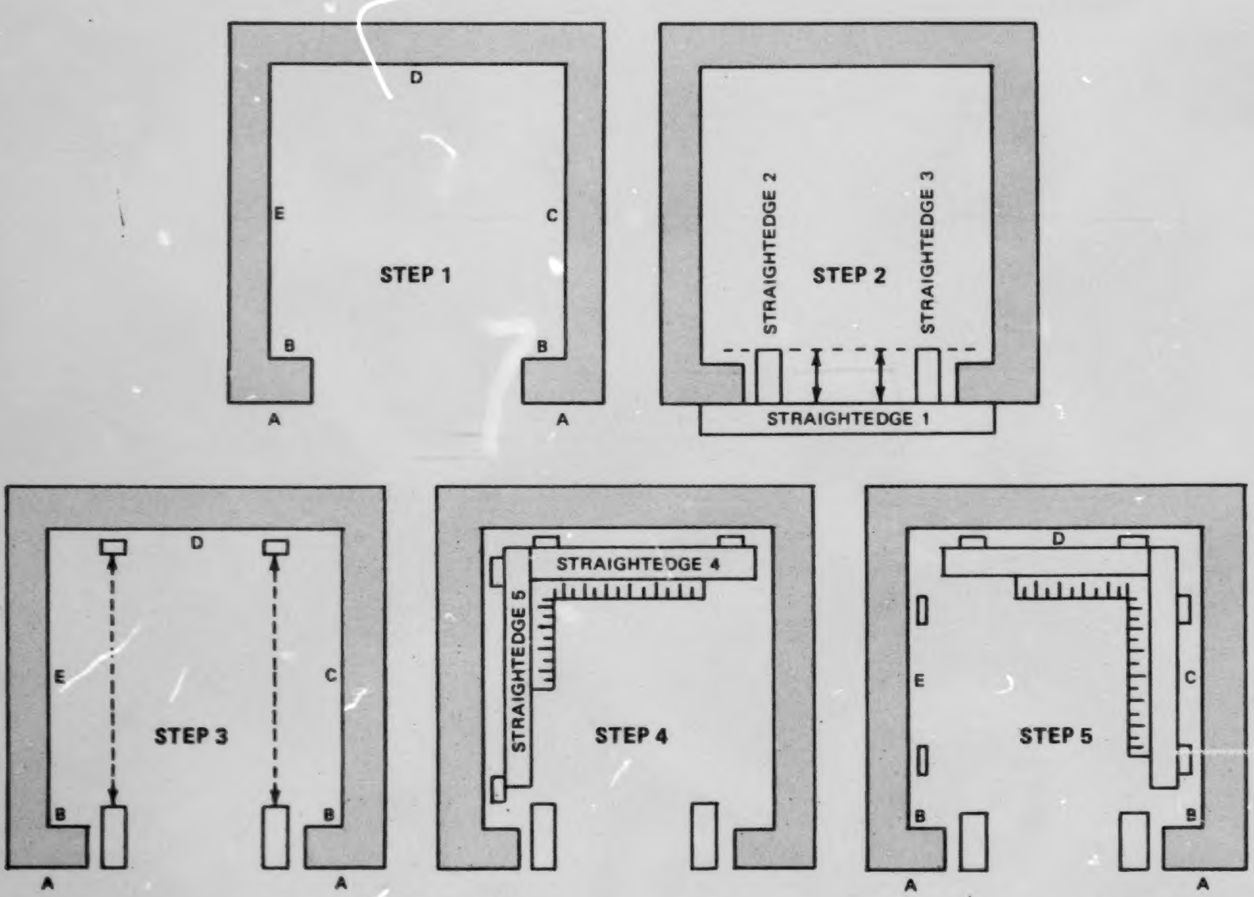
The tile shower is one of the bread-and-butter items of the tilesetter's trade. A steady demand exists for the tilesetter who can install a tile shower successfully regardless of the shape or size.

The procedures for squaring a shower are the following (see illustration below):

1. Check for plumb of wall A at the shower entrance. Determine points (if any) where the wall is out of plumb. (See illustrations below.)
2. Hold straightedge 1 across the shower opening, and secure straightedges 2 and 3 on the face of the jambs. These are set equidistant from straightedge 1.
3. Set float strips on wall D equidistant from straightedges 2 and 3.
4. Use framing square and straightedges 4 and 5 to set float strips on wall E square to wall D. Use straightedges and square to find if jamb edges are square with wall E also.
5. Use framing square and straightedges 4 and 5 to set float strips on wall C. Use tape rule to set strips parallel to float strips on wall E.
6. Make adjustments. If the spirit level and framing square have been used correctly, very few adjustments will be necessary.

Setting Diagonal Floors

All horizontal areas that are laid in a diagonal pattern should be centered in the same way that vertical



surfaces are centered. Where the floor has a border and the wall also is tiled, the border should be set so that its joints fall at the same places as the joints of the wall tile. Then, the diagonal half cuts should butt against this border. Some tilesetters slip the full diagonal cuts out of line and insert a straight cut; this should not be done, because the joint would be broken. The correct method of installing 4¼ by 4¼ inch (10.8 by 10.8 centimetre) tile is illustrated in Fig. D-2. The diagonal pieces are cut to fit the border. If a diagonal of less than ¾ inch (1.9 centimetres) remains, then the layout must be changed so that the small diagonal will measure 1½ inches (3.8 centimetres) to fit with the cut from which it has been taken. Thus, the large piece will be 4½ inches (11.4 centimetres). The tilesetter should experiment with the cuts so that they will fit the particular requirements of the tilework. This same principle applies regardless of the size of the tile used.

A beautiful example of a diagonal pattern for a kitchen counter is shown in Fig. D-3.

Closing Decorative Tile

When tile with a continuous pattern overlaps to such an extent that the discrepancy cannot be corrected by spreading the joints, the tilesetter should cut an equal amount off the last two tiles that finish the complete border around the pattern. This procedure will close the pattern. Tiles should always be cut in pairs. For example, when a swirl pattern is being set in place, the last two tiles should be cut; this will create a lesser swirl, but the remaining tiles will match (Fig. D-4). Some tilesetters will form a closure by cutting only one tile; this should be avoided. If the cut tile is running parallel with the other courses of tile, the other courses should be cut at the same place so that the joints will be uniform.

An example of a layout of a decorative pattern is shown in Fig. D-5.

Setting Hexagonal Tile Floors

In setting hexagonal tile floors, the tilesetter should use the same procedure as that given for diagonal layouts. Every effort should be made to maintain the full size of the border tile and to maintain the border pattern. Where the cuts on the tile edges result in tiles that are smaller than full halves or five-point cuts, the next course can be converted into elongated hexagons that are cut to fit. Five-point cuts or full halves then can be used along the edges (Fig. D-6).

Laying Out a Closure

A closure is used when tile is to be set around a series of doors or windows (Fig. D-7). The tilesetter can use a full tile or a large tile cut around the openings. To lay out a closure, the tilesetter centers the opening and inserts the cuts at the center or at either side of the door or window. If the ceiling is to be tiled, a closure cannot be used.

Setting Trim

Trim should always be backed up with setting mortar and a thin even coat of pure cement but never with tile grout or pure cement exclusively. If the tilesetter

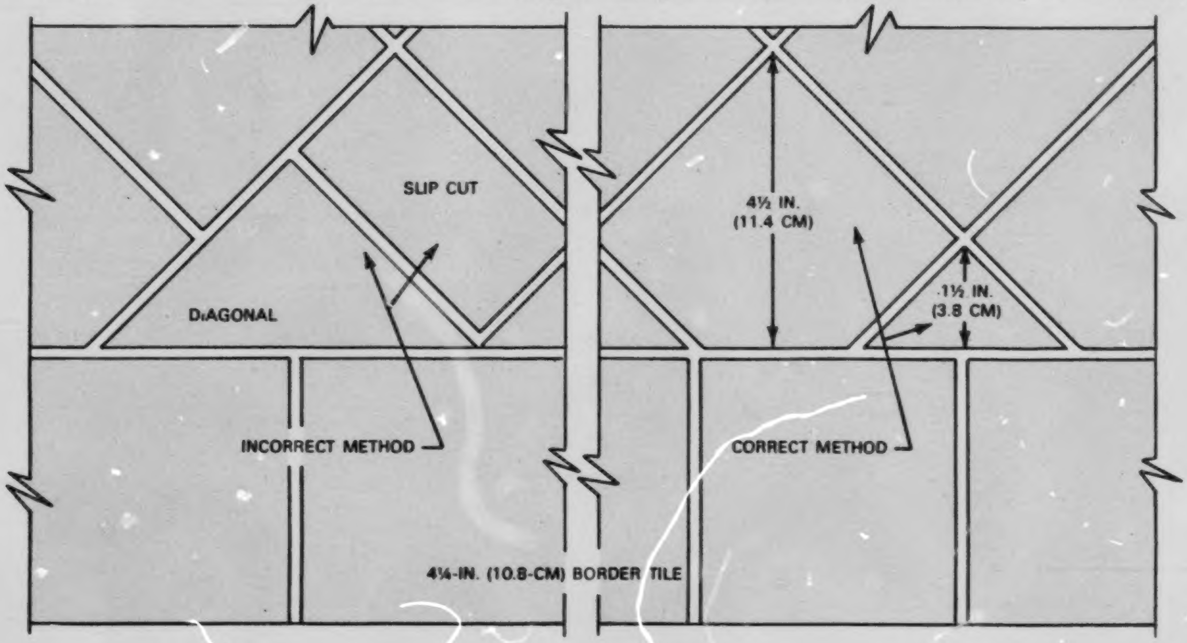


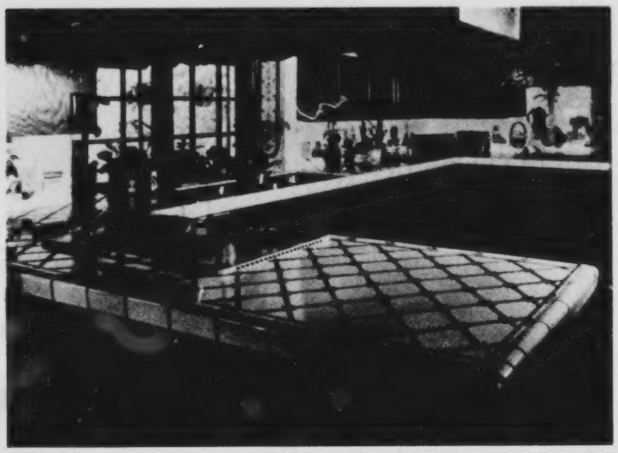
Fig. D-2. Diagonally laid tile floor

desires to leave a full backing for the trim, at the time of floating he or she should apply mortar beyond the finished dimensions of the area to be tiled and remove the excess mortar back to the finished dimensions. The pure coat of cement that is then troweled over the setting bed or applied to the trim unit should not be more than $\frac{1}{16}$ inch (0.2 centimetre) thick.

Fitting Sculptured Tile at Corners

To set sculptured or contoured tiles, the tilesetter must solve the problem of continuity of design at the corners. When these tiles are cut at the juncture of two internal walls, the tiles form an unsightly joint if they are cut square and butted. The tilesetter can eliminate this condition by using one of the following alternatives:

1. Use plain tile for the cuts at the corners (Fig. D-8).
2. Miter the sculptured tiles (Fig. D-9).
3. Cope the tiles to fit. (This is the least desirable method.)



See color reproduction on page 125.

Fig. D-3. Example of a diagonal pattern for a kitchen counter

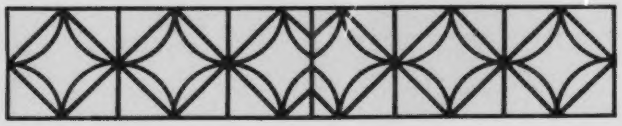
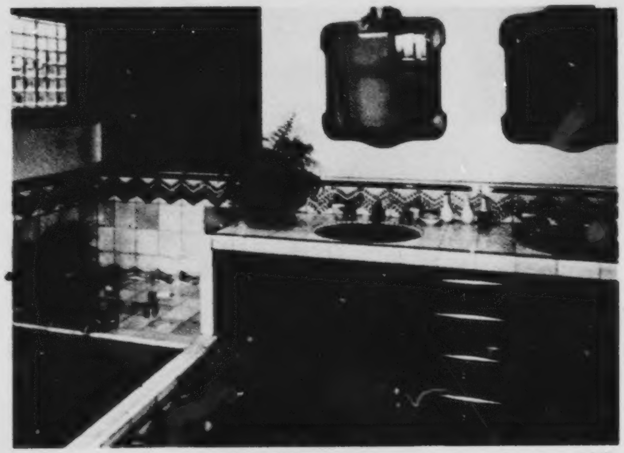


Fig. D-4. Closure in decorative tile with continuous pattern



See color reproduction on page 126.

Fig. D-5. Example of a decorative pattern for a bathroom

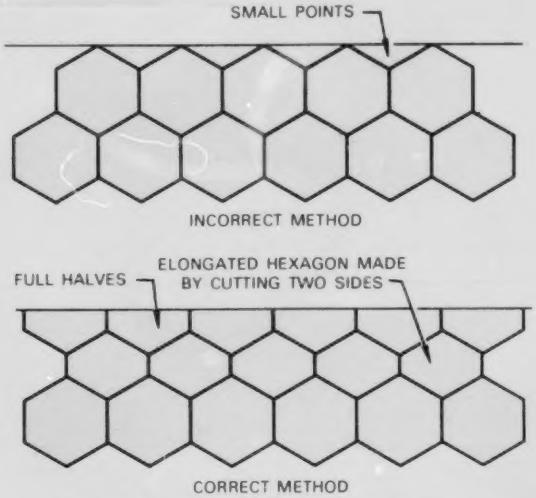

SMALL POINTS
INCORRECT METHOD
FULL HALVES
ELONGATED HEXAGON MADE BY CUTTING TWO SIDES
CORRECT METHOD

Fig. D-6. Layout of hexagonal tiles

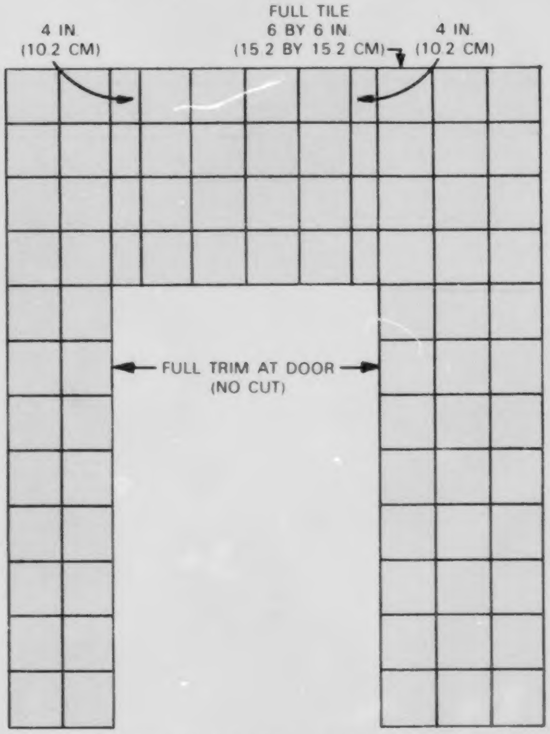

4 IN. (10.2 CM)
FULL TILE 6 BY 6 IN. (15.2 BY 15.2 CM)
4 IN. (10.2 CM)
FULL TRIM AT DOOR (NO CUT)

Fig. D-7. Layout of a closure around an opening

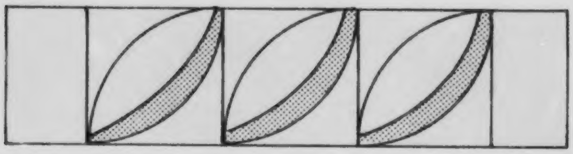


Fig. D-8. Layout with plain tile cuts at corners

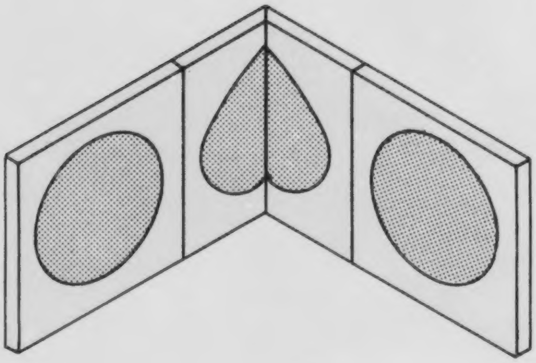


Fig. D-9. Mitered corner with sculptured tiles

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TOPIC 1 — TILE LAYOUT

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The centerline of a course of tile is on a joint when the course contains a(n) __1__ number of tiles. 1. ________

2. Decorative tiles should always be cut in __2__. 2. ________

3. The minimum size cut with which a course should end is __3__. 3. ________

4. In laying hexagonal tile floors, the tilesetter should maintain the full size of the __4__ tile. 4. ________

5. Trim should be backed up with __5__ mortar and a thin even coat of pure cement. 5. ________

6. The first operation in squaring a shower is to check the __6__ of the entrance wall. 6. ________

7. The float strips on the side walls should be __7__ from each other. 7. ________

8. All float strips must be __8__. 8. ________

9. To set sculptured tile, the tilesetter must solve the problem of __9__ of design. 9. ________

10. In the process of laying out a(n) __10__, the tilesetter can use a full tile or a large cut around a door or window. 10. ________

TOPIC 2 — PREPARATION OF VERTICAL SURFACES

This topic is planned to provide answers to the following questions:

- **How are vertical surfaces prepared for tilework?**
- **When is sandblasting required?**
- **How is dead cement removed?**

At least half the failures in tile installations can be traced to poor preparation of the surface before the tile is laid. The tilesetter should be able to prepare vertical surfaces for the installation of tile. Because local practices vary from place to place, familiarity with different techniques will help the tilesetter handle work in various locations.

Wood (Interior and Exterior)

All wood—including studs, plywood, particle board, and sheathing—should be adequately nailed if it is going to be used as a backing for tile. The wood should be fastened securely before the surface is prepared. All wood is to be covered with waterproof paper, wire, and mortar. Tile should not be bonded directly to wood surfaces.

Mortar

When mortar is to be applied over studs, the tilesetter should prepare the backing as follows:

1. Install tie wire if the studs are more than 8 inches (20.3 centimetres) on center.
2. Use approved vapor barrier with an overlap of at least 2 inches (5.1 centimetres).
3. Apply metal lath with an overlap of at least 2 inches (5.1 centimetres).

When the base consists of sheathing or plywood, tie wire can be eliminated, but the vapor barrier and metal lath are required.

Shower walls, installed in mortar, require special attention. This is because of the need for leakproof showers. The combined thickness of the waterproofing paper, reinforcing wire, scratch coat, mortar bed, and tile is not to exceed 1½ inches (3.8 centimetres). The thickness must be uniform from bottom to top.

Thin-Set Portland Cement Mortar

Thin-set portland cement mortars should not be used to adhere tile directly to painted or unpainted plywood, particle board, marine plywood, or sheathing. The flexibility and movement of wood make it a poor base for tile. Any movement will cause the tile to shear off.

Where thin-set cement is to be used, the mortar method should be followed. The wood should be covered with waterproof paper and metal lath. This is recommended over wood backing because the waterproof paper acts as a cleavage plane between the wood surface and the tile installation.

Organic Adhesive

Organic adhesives should not be used to adhere tile directly to plywood, particle board, marine plywood, or sheathing. The flexibility of the wood creates a hazard. The solvents in the adhesives cause the wood grain to move, and any movement may cause the grout to loosen and fall out. This is especially true when large sections of plywood are used.

Gypsum Plaster

The tilesetter should know the different methods of preparing gypsum plaster surfaces for the installation of tile.

Mortar

On a job where mortar is to be applied over gypsum plaster, a waterproof membrane and metal lath should be used. A scratch coat also may be needed.

Thin-Set Portland Cement Mortar

Where tile is to be installed with thin-set portland cement mortar, the tilesetter should use waterproof paper, metal lath, and portland cement mortar. Bonding directly to gypsum plaster with modified portland cement is not recommended for either wet or dry areas.

Organic Adhesive

In dry areas tile may be adhered directly to plaster with organic adhesives, but care must be taken to ensure that all moisture has left the plaster. Also, all dust and dirt must be removed from the surface of the plaster.

Gypsum Board (Wallboard)

The tilesetter often installs tile over gypsum board surfaces.

Mortar

The wallboard should be prepared with a waterproof membrane and metal lath before mortar is applied. A scratch coat may be required.

A one-coat method of installing ceramic tile over wallboard is shown in Figs. D-10 through D-15.

Thin-Set Portland Cement Mortar

Before tile is installed in wet areas with thin-set mortar, the surface must be prepared with waterproof paper, metal lath, and portland cement mortar. In dry areas tile may be adhered directly to gypsum board, but the surface must be free of dust and dirt.

Organic Adhesive

In dry areas organic adhesives may be used to adhere tile directly to gypsum board. All dust and dirt must first be removed from the surface.

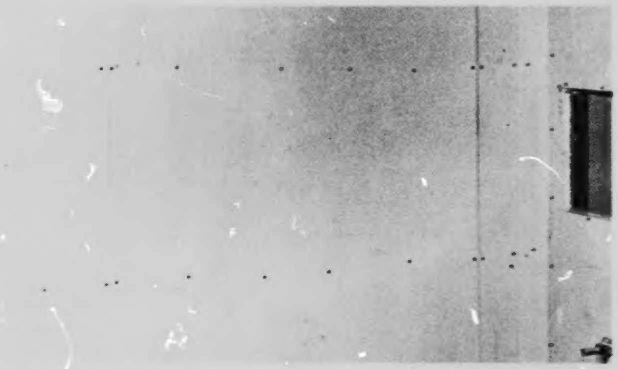

Fig. D-10. Gypsum wallboard ready for tile installation using the one-coat method

Fig. D-11. Mortared screed ready for floating the setting bed

Fig. D-12. Setting bed floated to a true and level plane

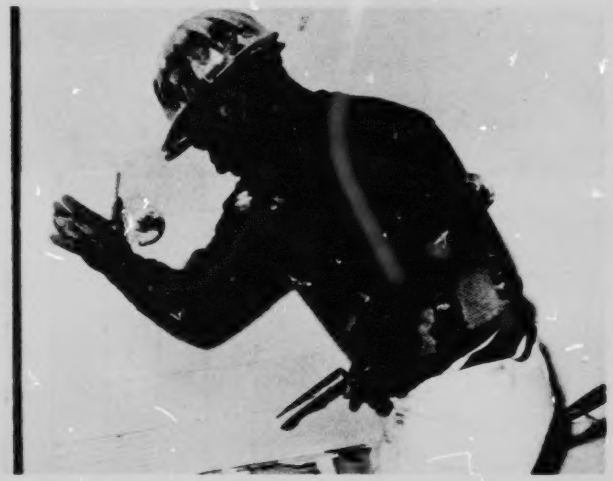

Fig. D-13. Applying bond coat and ceramic tile

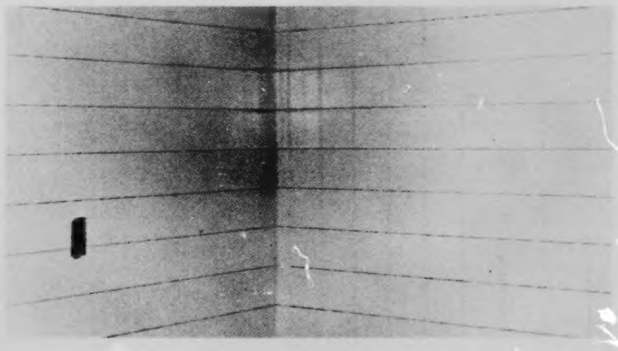

Fig. D-14. Tile walls (before grouting)

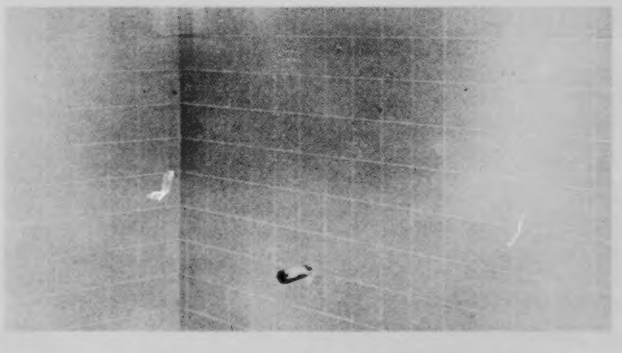

Fig. D-15. Completed tile walls after grouting

Glass Fiber Mesh Reinforced Board

The failure of ceramic tile installed over wood, over gypsum wallboard, or over gypsum plaster in wet areas is a problem that faces the building industry today. Glass fiber mesh reinforced board was developed to help solve this problem. Unlike wood and gypsum products, this material is unaffected by moisture, water, or steam. Because it is made of expanded shale and is reinforced with glass fiber and high-density portland cement, this board has one of the lowest coefficients of expansion or contraction in a wet environment of any building panel used in construction today. Because of this excellent dimensional stability, the material will not delaminate, decay, or disintegrate easily.

Glass fiber board weighs approximately 3½ pounds per square foot (1.6 kilograms per 0.09 square metre). It is available in one thickness (7/16 inch or 1.1 centimetres). Each board measures about 3 by 5 feet (0.9 by 1.5 metres). The boards can be scored, snapped, and secured to studs with nails or screws in minutes for the immediate installation of tile.

Where glass fiber board is installed over solid backings, such as plaster, gypsum board, or plywood, the fasteners must be long enough to penetrate the solid backings and anchor firmly to the wood or steel studs. This board is ideal for remodeling on surfaces that present bonding problems and where space limitations exist.

Glass fiber board is cut with a special scoring tool (Fig. D-16). The glass fiber reinforcement layer should be scored through on one side. After the board is snapped, the reinforcement is cut through on the reverse side with the same scoring tool.

The joints and corners are covered with a 2-inch-wide (5.1-centimetre-wide) coated glass fiber tape embedded in a skim coat of presanded thin-set or latex portland cement mortar (Figs. D-17 and D-18).

Openings for pipes or fixtures can be punched out with the edge of the head of a conventional hammer (Fig. D-19).

Ceramic tile must be bonded to the board with a presanded thin-set or latex portland cement mortar applied in one layer not less than 3/32 inch (0.2 centimetre) thick after the tiles are beaten in. The mortar must be applied first as a skim coat with the trowel's flat edge and then troweled with the opposite notched edge.

Poured and Tilt-Up Concrete

Interior and exterior walls of smooth concrete must be prepared before tile can be installed.

Mortar

The surface of smooth monolithic walls must always be sandblasted. After concrete surfaces are sandblasted, they should receive a dash coat mixed in proportions of one part portland cement to one and one-half parts graded sharp fine sand. A mix of one part antihydro to five parts water should be added to dry-mixed sand and cement as a wetting agent.

Control joints must be provided when ceramic tile is installed over concrete. Metal extrusions in the structure can often serve as control joints. Exterior

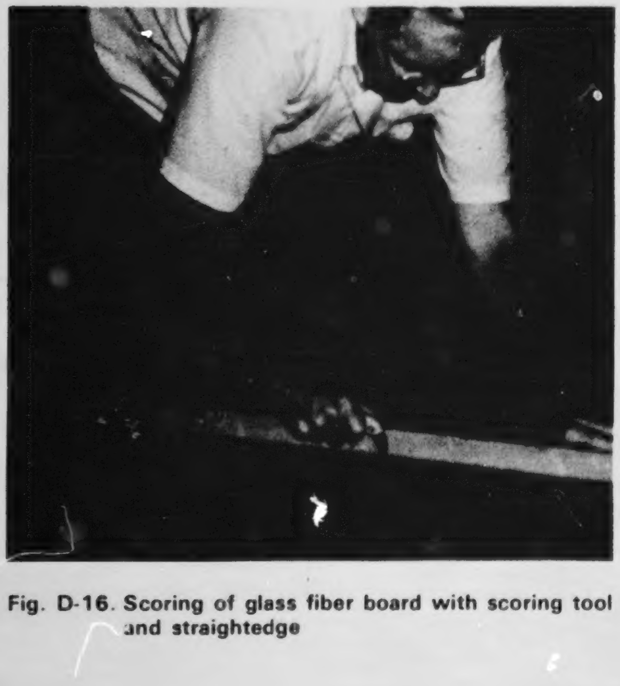

Fig. D-16. Scoring of glass fiber board with scoring tool and straightedge

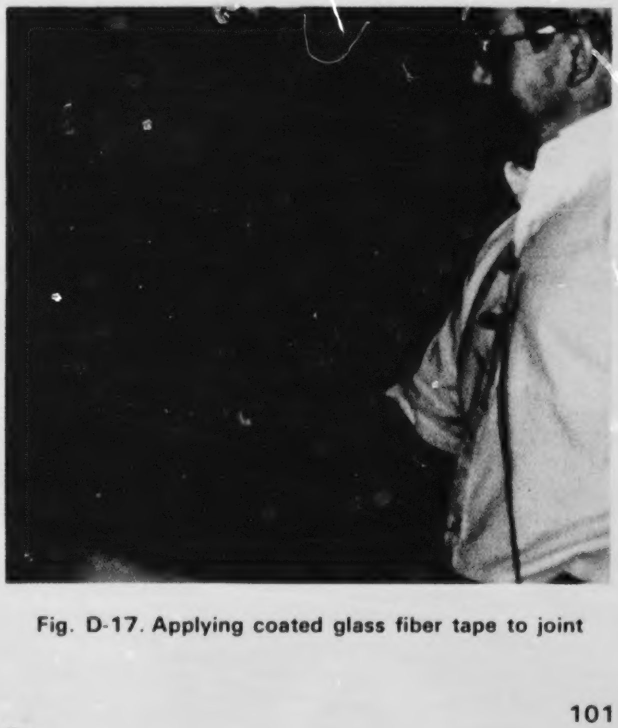

Fig. D-17. Applying coated glass fiber tape to joint

Fig. D-18. Applying coated glass fiber tape to corner

Fig. D-19. Knocking out hole with head of conventional hammer

installations should have control joints 16 to 20 feet (5 to 6 metres) apart in both directions. The joints between the tiles should not be wide and unsightly. They must, however, be continued through the tile and mortar setting bed and kept free of mortar and grout.

Thin-Set Portland Cement Mortar

When tile is to be installed with thin-set portland cement, sandblasting is essential on a smooth monolithic wall. Because a dash coat will not be applied, extreme caution must be observed. Job specifications must be followed closely. Sufficient control joints must be provided.

Organic Adhesives

The use of organic adhesives or mastics to set ceramic tile or glass mosaics on exterior concrete walls is not recommended.

Removal of Dead Cement

Dead cement is a layer of powdered cement on the surface of concrete. A good bond is difficult to achieve because the surface is powdered and the pores are closed. Dead cement is present on most large concrete surfaces. General contractors usually "kill" a layer of cement in order to be able to remove the formboards more easily. When the cement layer is not killed, the boards become adhered to the concrete. The contractors then have to break up the boards.

Other horizontal and vertical surfaces also may have a layer of dead cement. Some tilt-up concrete panels that are incorrectly prepared do not provide a good bond.

Tile trade standards require that concrete surfaces be sandblasted. Basically, the requirements for sandblasting are intended for vertical surfaces, but horizontal surfaces often need to be sandblasted or scarified to obtain a good bond.

The sandblasting should remove all of the dead cement. It should leave a roughened surface and open up small pores.

Before the requirement for sandblasting was established in the tile trade, other methods of treating the concrete were considered. These have not been adopted. Some of these other methods involve the use of acid etching, washing solutions, and so-called bonders. Several manufacturers of bond breakers claim that their products leave a bondable surface free of powder after the formboards have been removed. When these bond breakers have been used in the field, a powdery surface does remain, and it has to be removed.

In some situations sandblasting is not practical. The surface may have to be scarified with a grinding tool or a bushhammer.

Tile contractors continue to treat concrete surfaces with acids and bonders. They can use these materials if the written specification does not prohibit their use; however, if these contractors have a failure, they will receive no backing from the tile trade because they have not followed the recommendations of the tile trade. New methods will be adopted by the Job Problem and Technical Committee of the Ceramic Tile Institute only when they are proved successful.

Successful bonding of tile has been achieved when the concrete surface has been broom-finished or wood-float-finished. If either of these methods is used, scarifying of the surface is not necessary.

When tilt-up slabs of concrete are poured and stacked one over the other, they must be sandblasted to achieve a good bond. If sufficient space is available, the slabs can be poured separately. The surfaces then can be given a broomed finish.

Bond Testing

The actual tile and bonding material that will be used on the finished installation can be given a practical test. Pieces of tile 6 to 12 inches (15.2 to 30.5 centimetres) square can be set in three separate areas on the surface to be tiled. These should be allowed to cure three to seven days and then removed with a hammer and chisel. If the pieces shear off clean, a correct bond has not been obtained. If they are difficult to remove, and the bonding material breaks into the concrete, then a correct bond has been achieved.

Concrete Block and Brick

When the base material is concrete block or brick, the following materials and techniques are recommended.

Mortar

The tilesetter should be concerned with the possibility of cracking or movement of masonry. If the masonry wall moves or cracks, this will be reflected through the layer of tile because it is fastened directly to the masonry.

Such cracking of the tile can be minimized or prevented by covering the area with a good waterproof paper and reinforcing wire secured to the masonry or concrete block. When the paper and wire are placed over the masonry, the scratch coat is not used. The tile is set in one coat of mortar ½ inch (1.3 centimetres) thick.

When it is desirable to bond directly to a concrete block surface, no preparation is needed. Concrete blocks with the joints between them provide a good rough surface for a tile installation. The tile may be set in one coat of mortar ½ inch (1.3 centimetres) thick.

Brick masonry has an absorption rate that makes tiling difficult. This does not mean that it is impossible to work with or that tilesetters need to worry about not achieving good results. The use of various types of sealers to eliminate the absorption problem is not necessary and often will cause trouble.

Where the brick masonry is to retain its factory finish and not be plastered above a wainscot, the tile installation should be kept as thin as possible to achieve a neat appearing termination point at the bullnose trim.

Thin-Set Portland Cement

Thin-set portland cement can be used if the surface is smooth enough to receive tile and no movement is likely to occur.

Organic Adhesive

Organic adhesives are not recommended over concrete block or brick, because surfaces cannot be leveled correctly with these materials. Organic adhesives are not recommended for exterior installations.

Steel Studs

When the base is made of steel studs, the tilesetter should use polyethylene sheeting, metal lath, and a scratch coat.

Study Assignment

Standard Specification for the Installation of Tile-Lined Shower Receptors (and Replacements), Ceramic Tile Institute, CTI-R8-103-62. Read portion pertaining to walls.

TOPIC 2 — PREPARATION OF VERTICAL SURFACES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Tie wire is used on wood studs that are more than _1_ on centers.
1. ________

2. Before the mortar setting bed is applied to a masonry or concrete block wall, waterproof paper and _2_ _3_ should be applied.
2. ________
3. ________

3. The _4_ and _5_ in wood make it a poor base for bonding tile directly to it.
4. ________
5. ________

4. Smooth concrete walls should be _6_ before tile is applied.
6. ________

5. Bonding directly to gypsum plaster with _7_ portland cement is not recommended for either wet or dry areas.
7. ________

6. In dry areas tile may be adhered directly to gypsum board with _8_ _9_.
8. ________
9. ________

7. Dead cement is a layer of cement on the _10_ of concrete.
10. ________

8. Glass fiber board has one of the _11_ coefficients of expansion or contraction in a wet environment of any building panel.
11. ________

9. Mastics should not be used to set ceramic tile on _12_ _13_ walls.
12. ________
13. ________

10. Smooth concrete can be scarified with a(n) _14_ tool or a(n) _15_.
14. ________
15. ________

TOPIC 3 — SETTING TILE ON VERTICAL SURFACES

This topic is planned to provide answers to the following questions:

- **How are tiles applied on vertical surfaces?**
- **What are the recommended bond coats?**
- **What is meant by open time?**

After the vertical surfaces have been prepared correctly, the tilesetter should be ready to mix mortar and apply the tiles. An example of a tiled vertical surface is shown in Fig. D-20.

Application of Mortar

The entire area to be tiled should be covered with a thin coat of setting mortar. The tilesetter should apply this coat with long even strokes of the trowel, using as few strokes as possible. When the moisture in the mortar is not disturbed, the mortar will attain its natural set. The strength of the cement can be destroyed by adding excessive amounts of water and stirring too long; however, when the mixture is agitated, the set of the cement can be accelerated.

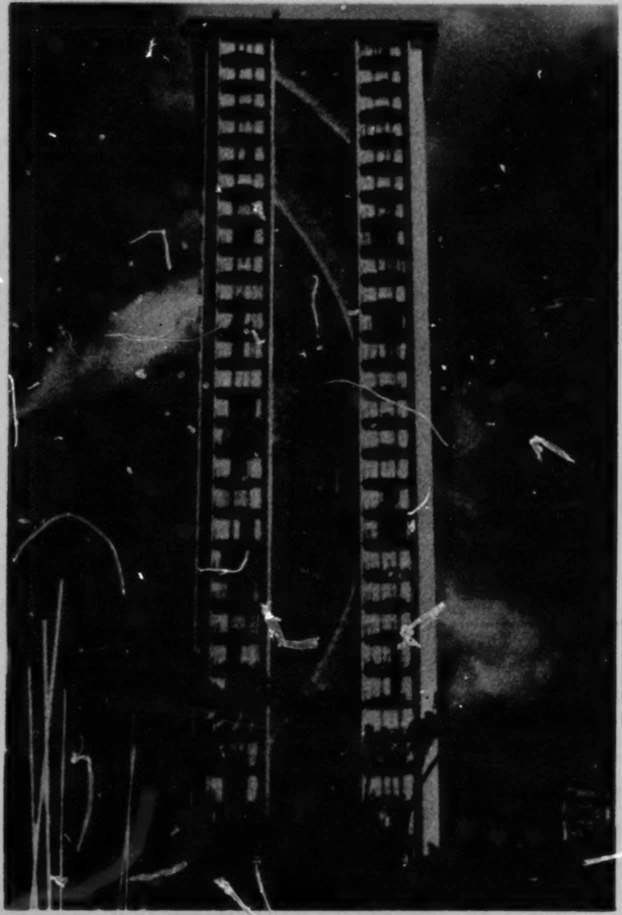
See color reproduction on page 127.

Fig. D-20. Example of a tiled vertical surface

Where temporary screeds are to be used, sufficient mortar should be applied in a ridge so that float strips can be plumbed. Float strips should be applied as near to the end of the wall as possible so that the task of maintaining plumbness will be facilitated.

The float coat or mortar setting bed should be applied in the same manner as the first coat. After the float coat has been completed, the temporary screeds can be removed by cutting each side of each screed strip to its depth with a pointing trowel. The strips can be removed by twisting and pulling upward at the same time. The tilesetter should then fill the voids left by the removal of the temporary strips and strike off the excess mortar with a straightedge not less than 12 inches (30.5 centimetres) long. Extra care should be taken not to leave a ridge or bulge on the mortar.

Before the tile is applied to a float coat that has hardened, the tilesetter should dash the float coat lightly with water (using a water brush) and, with circular motions, rub the float coat with a wood or rubber float or beating block to soften the surface.

Application of Tile

Tiles must be soaked for at least 30 minutes. Any excessive water should be drained off before the tiles are applied to the setting bed. Excessive water is water that is visible. Tiles that have been out of the water for more than 10 minutes should not be applied, especially in hot weather.

Bond Coat

The tilesetter should apply a pure cement and water mix that has been allowed to slack for about 20 minutes and has been remixed to a creamy consistency. This mixture should be applied $\frac{1}{32}$ to $\frac{1}{16}$ inch (0.1 to 0.2 centimetre) thick over the setting bed while it is still plastic; however, the area covered should be small enough so that the pure coat can be covered before it becomes glazed. A straightedge should be used to strike the coat of pure cement so that all the bulges caused by tipping the flat trowel are removed. The use of a scratcher on this coat of pure cement will help ensure a positive bond between the tile and mortar.

The first course of tile or base should be set on a screed that is absolutely level. The tilesetter should straighten this row and continue; however, no more than four rows should be set at one time. The tiles should be beaten in with a block that is free of sand or other abrasive material. The tiles should then be adjusted with a level straightedge, and the operation should be continued until the correct height is attained. If the mortar at the top of the wall has hardened, the tilesetter should apply pure cement to the trim before beating it in.

Every fourth course of tile, both vertical and horizontal, should have the float coat or setting bed cut to the scratch coat with a pointing trowel. This helps eliminate cracking of the walls.

Other Types of Bond Coat

If the specifications permit its use, gray or white thin-set portland cement mortar or latex-type portland cement mortar can be used with dry tile. This is to be done in strict compliance with the mortar manufacturer's directions. Thin-set or latex portland cement mortar is to be mixed slowly so that it does not become whipped up and filled with air bubbles. It should be given a 15-minute slack time before use, and it should be leveled to a thickness of $\frac{3}{32}$ inch (0.3 centimetre) after beating in the tiles. This is in addition to the mortar that fills in the ribs of ribbed tile. The tile should be cured 48 hours prior to grouting and be moist-cover-cured for at least 72 hours after grouting.

Prefloated Surfaces

If the specifications call for the tile to be set in accordance with American National Standard Specification A108.5, the requirements in that standard should be followed. The mortar setting bed should be prefloated in accordance with Specification A108.5 and allowed to harden prior to bonding the tile with thin-set or latex-type portland cement bonding mortar.

Open Time and Combing

Tests were made to show how the bonding strength of thin-set mortar was affected by open time. Open time is the interval between the combing of the mortar and the application of the tile.

At the request of the Ceramic Tile Institute, controlled tests were conducted at the Smith-Emery Company in Los Angeles. The test results are shown in Table D-1.

In Phase I of the tests, tiles were placed on the mortar 10 minutes after the mortar had been combed. Tiles were placed on the same mortar at other intervals. Final placement of tile was made 45 minutes after combing.

In Phase II of the tests, the original mortar was recombed, and additional tiles were set 5 minutes after recombing and at various intervals over a 25-minute period.

Results of the bond tests indicated that immediate placement of the tiles on freshly combed mortar provided the best bond. Results also showed that if the

TABLE D-1
RESULTS OF BOND TESTING

Condition of tile	Open time of thin-set mortar, min.	Number of taps	Bonded area, in.^{2} (cm^2)	Load, lb. (kg)	Bonding strength, lb./in.^{2} (kg/cm^2)
Dry	10	8	18 (117)	600 (270)	33.2 (14.9)
Dry	15	8	18 (117)	545 (245)	30.2 (13.6)
Dry	20	8	18 (117)	195 (88)	10.8 (4.9)
Dry	30	8	18 (117)	90 (41)	5.0 (2.3)
Dry	35	8	18 (117)	Failed	—
Wet	35	8	18 (117)	80 (36)	4.4 (2.0)
Dry	40	10	18 (117)	75 (34)	4.2 (1.9)
Wet	40	10	18 (117)	70 (32)	3.9 (1.8)
Wet	45	10	18 (117)	Failed	—
		(Mortar recombed)			
Dry	50	8	18 (117)	400 (180)	22.2 (10.0)
Dry	60	8	18 (117)	315 (142)	17.4 (7.8)
Wet	70	8	18 (117)	315 (142)	17.4 (7.8)
Dry	70	8	18 (117)	260 (117)	14.4 (6.5)
Wet	75	10	18 (117)	200 (90)	11.1 (5.0)
Dry	75	10	18 (117)	45 (20)	2.5 (1.1)

mortar has been in place for 15 minutes, it should be recombed. Other test results were the following:

1. Additional beating or wetting of the tiles will not help provide a bond on mortar that has set too long after combing.
2. Where tile is placed on recombed mortar, the bond will be satisfactory but not as good as the bond that is achieved on freshly combed mortar.
3. A better bond can be attained when the mortar is spread in thick gobs and is combined immediately before placing the tile.

Study Assignment

American National Standard Specifications A108.1 and *A108.5.* Read the foreword and general sections of the booklet.

UNIT D — JOB PROCESSES

TOPIC 3 — SETTING TILE ON VERTICAL SURFACES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Adding water and remixing mortar will tend to __1__ the mortar.
1. ________

2. Tile should be soaked for at least __2__ minutes.
2. ________

3. The best bond is obtained with thin-set portland cement mortar when the tile is applied within the first __3__ minutes after the mortar has been combed.
3. ________

4. Before tile is applied to a float coat that has hardened, the tilesetter should __4__ the float coat with water.
4. ________

5. The coat of pure cement should be __5__ to ensure a positive __6__.
5. ________
6. ________

6. Every __7__ course of tile should have the setting bed cut to the __8__ coat with a pointing trowel.
7. ________
8. ________

7. Open time is the interval between the __9__ of the mortar and the __10__ of the tile.
9. ________
10. ________

8. Immediate placement of the tiles on freshly __11__ mortar provides the best bond.
11. ________

9. Additional __12__ or __13__ of the tiles will not help provide a bond on mortar that has set too long after combing.
12. ________
13. ________

10. Where temporary screeds are to be used, sufficient mortar should be applied in a ridge so that __14__ __15__ can be plumbed.
14. ________
15. ________

TOPIC 4 — PREPARATION OF HORIZONTAL SURFACES

This topic is planned to provide answers to the following questions:

- **How are wood surfaces prepared for tilework?**
- **How are concrete surfaces prepared for tilework?**
- **How are steel surfaces prepared for tilework?**

Tilesetters may not always have to prepare surfaces for tile; however, they should become familiar with the job process.

Tiling Over Wood Surfaces

Before installing tile in the mortar method, the tilesetter should inspect the wood surface to determine whether or not it is suitable for tilework. Building paper should be applied so that it is lapped 3 inches (7.6 centimetres) at the sides and ends. The paper should be fastened securely to the wood. Shrinkage mesh should be installed without nailing and in such a way that it does not butt tightly against the walls or against other vertical surfaces. The edges should not be turned up. The mesh should be in the approximate center of the setting bed mortar.

Using Glass Fiber Mesh Reinforced Board

When glass fiber mesh reinforced board is installed over a wood subfloor, the subfloor must be structurally sound and well supported. The glass fiber panels, as well as the subflooring, should be clean and dry. A bead of high strength, waterproof construction adhesive is applied to the reverse side of the panel, around the entire perimeter about ¼ to ½ inch (0.6 to 1.3 centimetres) in from the edge and also in an "X" from the corners through the center. In addition, spots of the adhesive should be added in other areas of the panel to achieve extra bonding.

The panel is then laid in place and nailed every 8 to 10 inches (20 to 25 centimetres) around the perimeter and at several points in the center area to hold it in place while the adhesive sets and to further adhere the panel to the wood. In keeping with good construction practice, the joints between panels should not be directly over the joints between the sheets of plywood.

Another common method of installing glass fiber is to trowel a coat of latex portland cement mortar (instead of waterproof construction adhesive) onto the wood subfloor. The board is then set in the mortar and nailed to the wood subfloor. This method enables leveling when necessary to ensure a good installation.

As with the installation of glass fiber board on vertical surfaces, all joints should be taped with 2-inch-wide (5.1-centimetre-wide) coated glass fiber tape embedded in a skim coat of presanded thin-set or latex portland cement mortar.

Bonding to Concrete Surfaces

Before the mortar setting bed is placed, concrete surfaces must be inspected by the tilework contractor. The surfaces must be clean, free from oil or grease, and without projections, depressions, holes, joints, or loose particles.

Immediately before the mortar setting bed is to be placed, the surface should be thoroughly saturated; however, water should not be allowed to stand free. Neat portland cement and sand should be brushed on with a broom or brush. This will ensure a good bond.

Sometimes a fill is required to bring the floor level to the correct grade for receiving the mortar setting bed. The fill must consist of a durable aggregate that is free from large amounts of deleterious substances. Aggregate must be graded from fine to coarse within the limits of ¼ inch (0.6 centimetre) to a size one-half the thickness of the concrete fill. The fill should consist of one part portland cement, three parts sand, and four parts coarse aggregate. Care should be taken to limit the use of water.

The concrete fill is poured over the structural subfloor and brought to the correct level. The shrinkage mesh is placed over the fill.

Cracked or uneven floors should not be covered. Contractors who are ordered to lay tile over cracked concrete should protect themselves by describing the condition of the floor in a written statement.

Using an Isolation Sheet

Tile should not be bonded to a nonreinforced concrete slab on grade. An isolation sheet should be used over the slab, which has been finished smooth and even. The tile should be installed over the sheet, using the mortar method, with reinforcing wire in the approximate center of the mortar settng bed.

On an above-grade concrete slab, tile should be installed over an isolation sheet, using the wire-reinforced setting bed method. Some concrete slabs are designed so that the deflection is kept within the tolerances established by good engineering practices. Experience has proved, however, that almost all reinforced concrete slabs above grade do move over a period of time and are subject to bending and deflection. Nonreinforced concrete slabs can be poured over metal decking or metal pans. The isolation sheet method should be used on these floors. This method also should be used over precast concrete floors and over precast concrete plank floors.

Modern methods of construction make it difficult to depress the concrete the 1½ to 2 inches (3.8 to 5.1 centimetres) necessary for the tile installation. The marble threshold, which was forgotten for many years, is being revived. It provides the space needed for the installation of tile.

Bonding to Steel Surfaces

Steel must be clean and free from loose rust or scale. When the plates are not preformed to provide a key, then a shrinkage mesh must be bolted or spot-welded over the entire surface to form a bond with the mortar setting bed.

Installing Shower Receptors

Tile-lined shower floors need special preparation, because they must conform to the Uniform Plumbing Code and they must be free of any leaks.

Study Assignment

Standard Specification for the Installation of Tile-Lined Shower Receptors (and Replacements), Ceramic Tile Institute, CTI-R8-103-62. Read portion pertaining to the receptor, floor, base, and curb.

UNIT D — JOB PROCESSES

TOPIC 4 — PREPARATION OF HORIZONTAL SURFACES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Concrete surfaces must be free of projections, depressions, and loose particles and must have no 1 or 2 on them.
   1. __________
   2. __________

2. On wood construction, after the building paper has been applied, the 3 4 should be placed so that it is free from the walls.
   3. __________
   4. __________

3. In the preparation of horizontal wood surfaces for tile, the building paper is lapped 5 at sides and ends.
   5. __________

4. Before the mortar setting bed is placed, the concrete surface should be thoroughly saturated with 6.
   6. __________

5. The concrete fill is mixed in the proportions of 7 part(s) portland cement, 8 part(s) sand, and four parts coarse aggregate.
   7. __________
   8. __________

6. Steel plates that are not preformed to provide a key must have a(n) 9 10 bolted or spot-welded over the entire surface.
   9. __________
   10. __________

7. Tile should not be bonded to a(n) 11 concrete slab.
   11. __________

8. Tile should be laid over a(n) 12 sheet by the mortar method.
   12. __________

9. The 13 14, which was forgotten for many years, is being revived.
   13. __________
   14. __________

10. Almost all reinforced concrete slabs that are 15 grade move over a period of time.
   15. __________

TOPIC 5 — SETTING TILE ON HORIZONTAL SURFACES

This topic is planned to provide answers to the following questions:

- **How are tiles set on horizontal surfaces?**
- **What methods are used to apply the pure coat?**
- **How is the grout cured?**

Setting tile on horizontal surfaces consists primarily of setting tile on subfloors and concrete floors. This is, of course, a phase of the work that the apprentice tilesetter should learn. Varying local practices require that the apprentice learn different procedures for setting tile.

The tilesetter should know why a certain method of installing tile has been selected by the architect. The architect or engineer usually selects the method to be used after the concrete slab has been inspected and evaluated.

Positioning the Reinforcing Wire

When concrete slabs are poured, a technique must be devised to position the reinforcing bars in the approximate center of the slab. Concrete should never be poured over reinforcing bars that have been laid flat on the bottom of the forms. The reinforcing wire must be placed in the approximate center of the bed.

The reinforcing wire can be positioned by one of the following methods:

1. Crimped wire can be used to position the reinforcing wire in the center of the mortar bed.
2. Spots of mortar can be placed to support the wire in the center of the mortar bed.
3. Large pieces of foreign material, such as tile, can be used, but they are difficult to remove. They should not be left in the completed tile installation.

Rolled wire should be taken off the roll so that the curve of the wire faces the floor. The ends of the wire should bend down toward the floor. The wire should not be kinked or bent. The pieces of wire should be lapped at least one full mesh.

Planning for the Areas of Stress

Expansion joints need to be planned and prepared for well in advance of setting the tile. Much of the pressure can be removed from the mortar setting bed by placing a compressible type of polyethylene foam in between the mortar setting bed and the adjoining surface.

Preparing the Mortar Setting Bed

Sufficient water must be added to the mortar mixture so that a ball can be formed when the mortar is squeezed in the hand. When the hand is released, the mortar should hold together. The mortar mixture should be of such consistency that the troweled surface will be smooth and slick. Before the floor is screeded, the mortar should be soundly compacted.

If the mortar setting bed has the correct amount of moisture and the pure coat has been applied correctly, an instant bond will be achieved when ceramic mosaic tile is set in place. The tilesetter should lift the edge of a sheet of tile occasionally to ensure that the instant bond is being achieved.

Using Extra Fine Sand

Extra fine graded sand should be used in preparing the mix of half sand and half cement. The Ceramic Tile Institute has issued Standard CTI-70-6 for extra fine sand. Its field report No. CTI-70-1-8 describes how this sand should be used. One-grit sand should never be used for the half-and-half mix.

The half-and-half mix should be dampened before it is swept into the joints of the floor. After the mix is swept, the floor is to be beaten in sufficiently to form a monolithic bond.

Curing the Grout

To forget to cover and wet-cure the grout is a very serious mistake. Experience has proved that a hard, dense, well-cured grout is essential if a ceramic mosaic floor installation is to be a success. Specification ANSI A108.5 requires that the grout be kept damp for at least 72 hours to ensure a correct cure.

Preparing a Concrete Slab

When the mortar setting bed is going to be bonded directly to the slab, the slab can be left rough, but it should be on a plane that will give a uniform depth for the mortar bed. When the floor is going to be installed over an isolation sheet or membrane, the concrete should provide an even thickness for the setting bed. Rough spots that are either projected above the surface or are depressed into the surface must be eliminated.

When tile is going to be bonded directly to the concrete slab, in the thin-set method, the general contractor or concrete contractor should be advised to provide a wood float finish. No curing agents should be used.

If the surface is not adequate, the tilesetter should insist that it be scarified before the tile is installed.

Using Sufficient Mortar

The proper amount of thin-set and latex-type portland cement bonding material must be used. Specification ANSI A108.5 requires that the bonding mortar have a thickness of at least $\frac{3}{32}$ inch (0.2 centimetre). The same specification also requires 100-percent coverage.

The bond strength of thin-set portland cement bonding mortar is greatly improved if it is cured under cover for at least 72 hours.

Applying the Setting Bed

The mortar for the setting bed should be mixed by volume in the proportions of one part portland cement and five to six parts sand. The mortar should be applied to a thickness that will allow proper grade over an area no greater than that which can be covered with tile before the initial set takes place. Screed strips should be placed to ensure the required slopes or levels. As a general rule, the mortar should not be retempered (remixed with water); however, water that evaporates may be replaced.

The mortar setting bed is in no sense intended to add structural strength to the construction of the floor. The amount of thickness, therefore, is determined by the leveling required for the floor and by the depth needed to provide a plastic mass to which the tile will adhere adequately.

On level subfloors the mortar setting bed usually should be not less than 1 inch (2.5 centimetres) thick. Under unusually favorable circumstances where levels are extremely accurate, satisfactory installations have been made with setting beds as thin as $\frac{3}{4}$ inch (1.9 centimetres).

When the subfloor is not level, the mortar setting bed should be 1 inch (2.5 centimetres) thick plus the greatest expected deviation from the required level. A thickness of $1\frac{1}{4}$ inches (3.2 centimetres) usually will be acceptable and will take care of most situations.

Setting Tile

Before the tile is laid and before the mortar setting bed has reached its initial set (as specified), the setting bed should have sufficient moisture on its surface to wet a dusting of a thin layer of dry portland cement approximately $\frac{1}{16}$ inch (0.2 centimetre) thick. Immediately before the tile is to be set, the tilesetter should work the surface lightly with a brush or trowel to provide a coat of neat cement that will result in a good bond. In addition, a skim coat of neat portland cement mortar should be applied to the backs of the single unmounted tiles or sheets of mounted tiles as they are laid.

The tiles are placed on the freshly laid setting bed while it is still plastic. The required slope or level is established by placing straightedges at regular intervals. The tiles are pressed or beaten into the mortar until they are at the correct level.

Using the Thin-Set Method

When tile is to be bonded to concrete with thin-set or latex portland cement mortar, the surface of the concrete must be on-plane, clean concrete; slab-on-grade construction without bending stresses; well cured; dimensionally stable and free of cracks; and free from waxy or oily films or curing compounds.

The concrete should have a steel trowel and fine broom finish and be moistened prior to tiling. Where the tiles have ribs or high projections on the bondable side, they should be back-buttered.

Thin-set or latex portland cement mortar should be mixed slowly so that it does not become whipped and filled with air bubbles. After it is mixed, it should be given a 15-minute slack time before being used.

The mortar should be leveled to a thickness of $\frac{3}{32}$ to $\frac{1}{8}$ inch (0.2 to 0.3 centimetre) after the tile has been beaten in. This is in addition to the mortar that is needed to fill the ribs on rib-backed tiles.

The tile should be cured for 48 hours prior to grouting and be moist-cover-cured for at least 72 hours after grouting.

Installing a Shower Floor with Border

A diagonal shower floor with border is installed as follows (Fig. D-21):

1. Cut tile C in wall Y at corner of shower.
2. Cut tile B in wall X at corner.
3. Set full tile A on floor at corner.

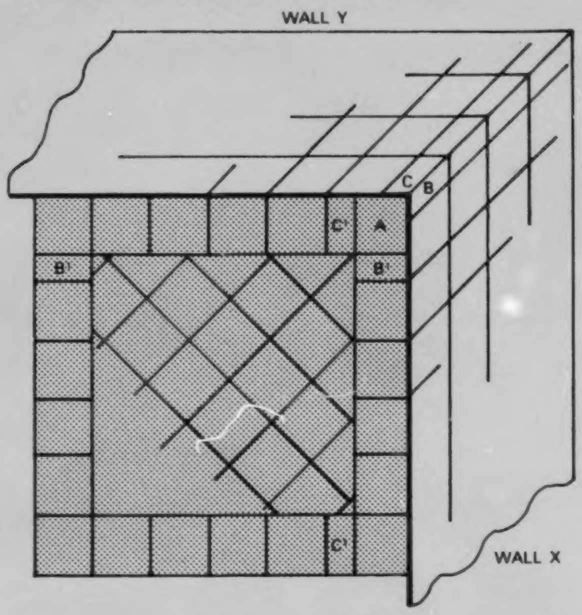

Fig. D-21. Layout of a diagonal floor with a border

4. Cut tile B^1 same size as tile B.
5. Cut tile C^1 same size as tile C.

When a full tile is set at each corner, the border lines will continue unbroken to the walls. This layout holds true if a bullnose or sanitary cove base is used.

Laying Out Patterns

When a floor is to have patterns and borders, the tilesetter must ensure that the fields or patterns are centered. Whenever possible, no tile should be cut smaller than half its size. The borders and other lines required by the design should be laid out before the fields of horizontal surfaces are tiled. The inner edges of the borders or the edges against the field must be kept straight. Any minor cutting for irregularities should be done along the outer edges.

Determining Width of Joints

When sheets of paper-mounted ceramic mosaic tiles are being laid, the standard mounting width should be maintained between units. All other tiles should be installed with joints as shown in Table D-2.

The widths should not vary from those shown in the table unless the specifications direct otherwise. The architect may wish to achieve special design effects. Variations in the joint width also may be made by a skilled tilesetter who determines that the tile units will be accommodated more easily in a given space if another joint size is selected.

Fractional pieces of tiles in ceramic mosaics are sized so as to allow the various multiples to work together into patterns with a standard joint. Tiles that are unmounted present a challenge to the designer in color and width of mortar joints and in the introduction of other materials into the tilework design. Experienced tilesetters should be able to devise new and pleasing effects. But even when tilesetters lay out new patterns, they should use the standard joint widths as outlined in the table.

TABLE D-2
JOINT SIZES FOR TILE

	Joint size, in. (cm)
Mounted, $2\frac{3}{16}$ in. (5.6 cm) square or smaller	$\frac{1}{16}$ to $\frac{1}{8}$ (0.2 to 0.3)
Mounted, more than $2\frac{3}{16}$ in. (5.6 cm) square	$\frac{1}{16}$ to ¼ (0.2 to 0.6)
Unmounted, $2\frac{3}{16}$ in. (5.6 cm) to 4¼ in. (5.6 to 10.8 cm) square, unglazed	$\frac{1}{8}$ to ¼ (0.3 to 0.6)
Unmounted, 6 by 6 in. (15.2 by 15.2 cm) and more, unglazed	¼ to ¾ (0.6 to 1.9)
Quarry, unmounted	$\frac{3}{8}$ to ¾ (1.0 to 1.9)
Glazed, 3 in. (7.6 cm) square and more	$\frac{1}{16}$ to ¼ (0.2 to 0.6)
Faience, all sizes	$\frac{1}{8}$ to ½ (0.3 to 1.3)

Curing Floors

As soon as pointing or grouting of a tiled floor or other horizontal surface is completed, the entire area should be covered with polyethylene sheeting. Laminated and reinforced kraft paper with a bituminous binder also may be used. The sheeting or paper should be lapped at least 4 inches (10.2 centimetres). The edges should be sealed with tape, weights, or planks to prevent moisture from escaping. Three full days should be allowed for adequate curing of the joints. Because the joints in a tile floor are the most permeable and weakest part of the installation, correct curing is particularly important for floors that are to undergo severe service. In addition, the covering protects the floor from stains and construction dirt.

Cleaning Tiled Surfaces

When unglazed ceramic mosaic or quarry tile is installed, the face of the tile usually is covered with a light cement residue. Sulfamic acid is the best cleaner that can be used to remove this residue. Every tilesetter should know the correct method of using sulfamic acid.

Sulfamic acid will not remove heavy residue or large pieces of mortar. These should not be left on the surface of a correctly finished installation. This acid will not remove other kinds of dirt, stain, glue, grease, or paint. It may cause these materials to adhere to the tile even more firmly.

The tiled surface should be acid cleaned only once. Repeated cleanings can be harmful. A new installation should never be acid cleaned. Floors should cure for at least 14 days before cleaning.

The work should be done only by workers who are experienced in doing acid cleaning. The acid should be measured into an acid pail in proportions of 1 pound (0.45 kilogram) of sulfamic crystals to 5 gallons (19 litres) of clean water.

The surface to be cleaned must be saturated with water as far in advance of acid cleaning as possible (at least 60 minutes). This is one of the most important steps in acid cleaning. If the joints are dry, they will absorb the acid solution and be adversely affected.

Only a small amount of acid solution should be prepared at one time. It should be kept clean, and it should be replaced as needed. When large amounts of acid solution are prepared, precipitated acid salts will be collected. These will react with the cement residue and make it difficult to remove.

The surface should be scrubbed with a brush and then given several rinsings with clean water. The cement residue should be rinsed away as soon as it is dissolved. Immediate rinsing will prevent the acid salts from combining with the residue on the surface.

All metal surfaces should be protected with vaseline before the acid solution is used on the tiles.

UNIT D — JOB PROCESSES

TOPIC 5 — SETTING TILE ON HORIZONTAL SURFACES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The troweled surface of the mortar setting bed should be _1_ and _2_, which indicates that sufficient moisture is present.

1. ________
2. ________

2. Reinforcing _3_ must be positioned in the approximate center of a cement slab.

3. ________

3. The half-and-half mix of sand and cement should be _4_ before it is swept into the joints.

4. ________

4. The setting bed should be _5_ before it is screeded.

5. ________

5. When tile is to be bonded directly to a concrete slab, the concrete contractor should give the slab a(n) _6_ _7_ finish.

6. ________
7. ________

6. Bonding mortar should have a thickness of at least _8_ inch(es).

8. ________

7. The bond strength of thin-set portland cement bonding mortar is improved if it is cured under cover for at least _9_ hour(s).

9. ________

8. Setting bed mortar is mixed in proportions of _10_ part(s) portland cement and _11_ to _12_ part(s) sand.

10. ________
11. ________
12. ________

9. The required slope or level is maintained by the use of _13_ _14_.

13. ________
14. ________

10. The thickness of the mortar setting bed is determined by the _15_ needed to provide a(n) _16_ _17_.

15. ________
16. ________
17. ________

11. On level subfloors the mortar setting bed usually should be not less than _18_ inch(es) thick.

18. ________

12. Before the mortar setting bed has reached its _19_ _20_, a _21_-inch-thick layer of dry portland cement should be dusted on the surface.

19. ________
20. ________
21. ________

13. Tiles should be placed on the setting bed while it is still _22_.

22. ________

14. A _23_ tile set at each corner of a shower floor allows the border lines to continue _24_ to the walls.

23. ________
24. ________

15. Building paper placed over tilework during the curing process should be lapped at least _25_ inch(es).

25. ________

UNIT D — JOB PROCESSES

TOPIC 6 — CLEANING AND PROTECTING CERAMIC TILE AFTER INSTALLATION

This topic is planned to provide answers to the following questions:

- **How should newly installed tile surfaces be cleaned?**
- **How should tile surfaces be maintained?**

When the apprentices are working at their trade, owners often ask them how to clean tile. The apprentices should know what to recommend for daily and long-range cleaning of ceramic tile.

On jobs where remodeling or repair work is to be done, it may be necessary to protect existing ceramic tile installations that are to be used in the remodeled structure. This is accomplished by coating the tiled surface with an undiluted neutral liquid soap. Such soaps are low in acid or alkali content. The film of soap prevents construction dirt from adhering to the tile. When construction is completed, the soap film is washed off and the construction dirt comes off with the soap film.

When this method was first practiced on a neglected tile surface, an unexpected benefit was discovered. Not only was the surface protected during construction, but the neutral soap, which had soaked into the film of accumulated scum, cleaned the tile as if it were newly installed.

The maintenance department of the Los Angeles Unified School District discovered that this was an excellent way to periodically clean large gang showers and drying rooms. The tile industry now recommends these same procedures.

Cleaning Newly Installed Surfaces

Tile is not a magic material that will clean itself, but it is a relatively easy surface to clean. The tile and grout should be cleaned as one solid surface. The grout does not require separate scrubbing.

The animal fat soaps are compatible with portland cement grouts. These soaps, in contact with the portland cement grout, form a slick stearate film covering over the grout, leaving it easy to clean. Neutral soaps are now recommended because very few animal fat soaps are available. Most soap manufacturers have turned to detergents. Fels-Naphtha bar soap, which is an animal fat soap, is best when grated and dissolved into a liquid soap. It is the best soap for the treatment of newly installed surfaces of ceramic tile.

The new tile surface should be washed with warm water and a neutral soap. It should then be rinsed and polish-dried with towel rags. This step should be repeated every two to three days for the first month. After the first month, the tile only needs to be wiped with a damp cloth or sponge for daily upkeep.

Maintaining Ceramic Tile Surfaces

Tile surfaces should be cleaned daily with a damp cloth or sponge. The entire surface then should be polish-dried with towel rags. Thorough cleanings should be scheduled at weekly or monthly intervals. Regular household cleaning products, such as a neutral soap and scouring powder, should be used.

Cleaning Neglected Tile Surfaces

When a ceramic tile surface has been neglected over a period of time, it can be cleaned as follows:

1. With a soft cloth or brush, coat the entire surface generously and thoroughly with undiluted neutral soap. *Allow coated surface to dry and stand for several hours* (overnight for neglected surfaces).
2. Mix a neutral soap with warm water at the same strength as normally used. With this warm solution, wet down tile surface.
3. While the surface is wet, sprinkle a small amount of scouring powder over the tile and grout joints. Then scrub with a stiff brush.
4. Use a sponge, squeegee, or cloth to wash down the tile surface and to remove the soap film. Polish the surface dry with a towel rag or similar cloth.

Leaving Warnings with Owners

Waxes and sealers are not necessary for tile and are not recommended. They make the cleaning process more difficult.

Bottled liquid cleaners are not needed or recommended. Most of these contain harmful acids that may etch the tile glaze and eat into the grout.

TOPIC 6 — CLEANING AND PROTECTING CERAMIC TILE AFTER INSTALLATION

Study Guide

Determine whether the sentence is true or false, and write true or false in the corresponding blank at the right.

1. The apprentice should have some knowledge of how to clean ceramic tile after it is installed. 1. ________
2. Any kind of soap is suitable for cleaning ceramic tile. 2. ________
3. Tile cannot be protected when remodeling work is being done. 3. ________
4. Coating neglected tile surfaces with a neutral soap will loosen the dirt and make it easier to clean. 4. ________
5. Tile is a material that does not need to be cleaned. 5. ________
6. Tile and the grout joints are relatively easy to clean. 6. ________
7. Animal fat soaps are compatible with the portland cement grouts. 7. ________
8. Treating a new tile installation with animal fat soap or neutral soap is recommended. 8. ________
9. After cleaning, the tile should be polished with dry towel rags. 9. ________
10. Daily upkeep need only be done with a damp cloth or sponge. 10. ________

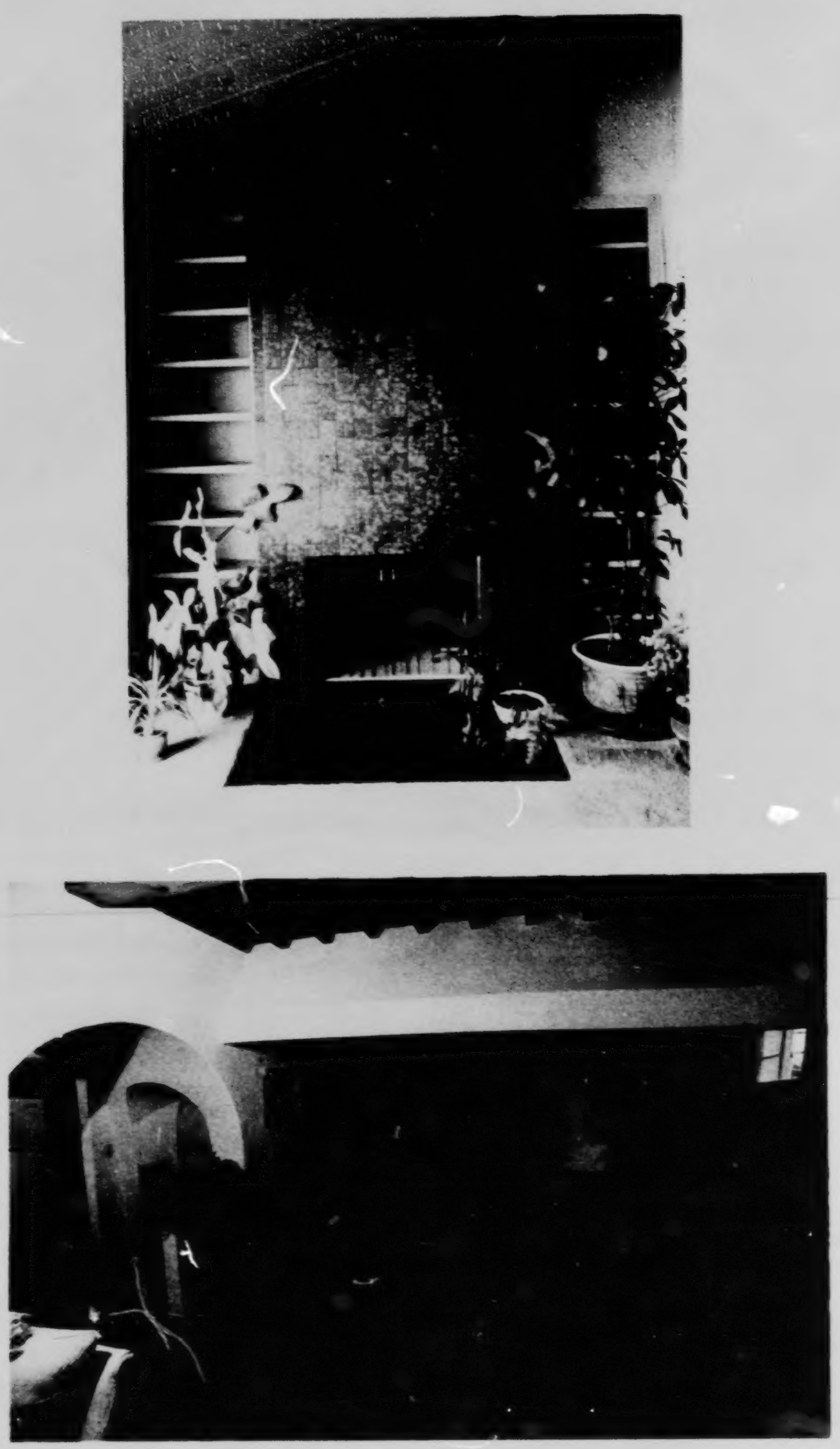

Fig. B-4. Glazed tile installed on fireplace hearth and facing (two examples).

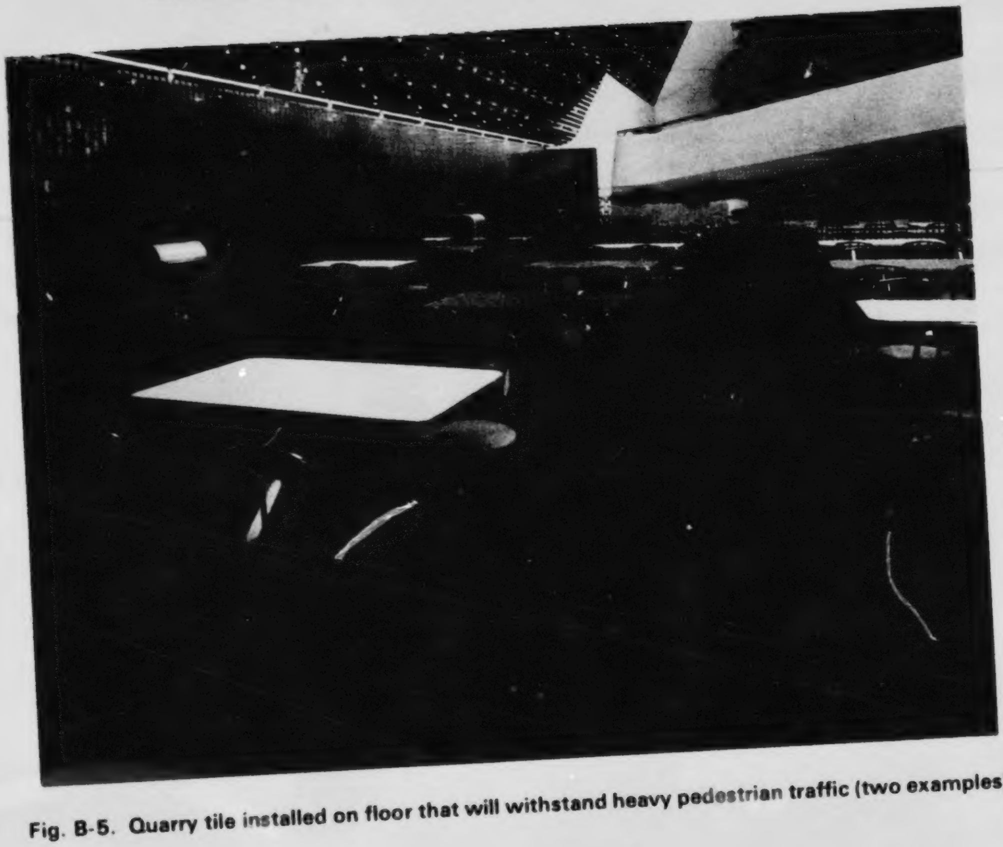

Fig. B-5. Quarry tile installed on floor that will withstand heavy pedestrian traffic (two examples)

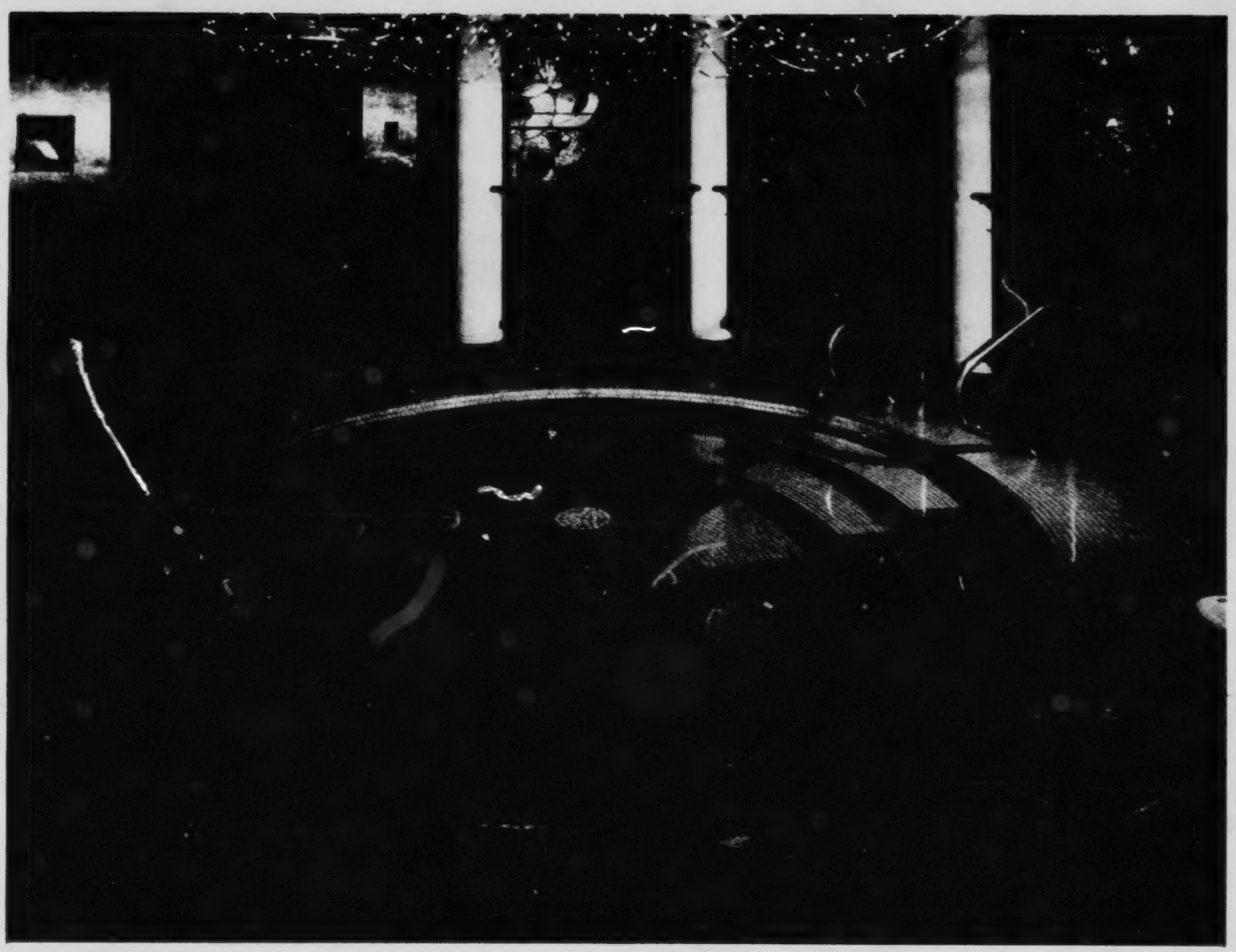

Fig. B-6. An example of ceramic mosaic installation at Racquetball World, Fountain Valley, Calif.

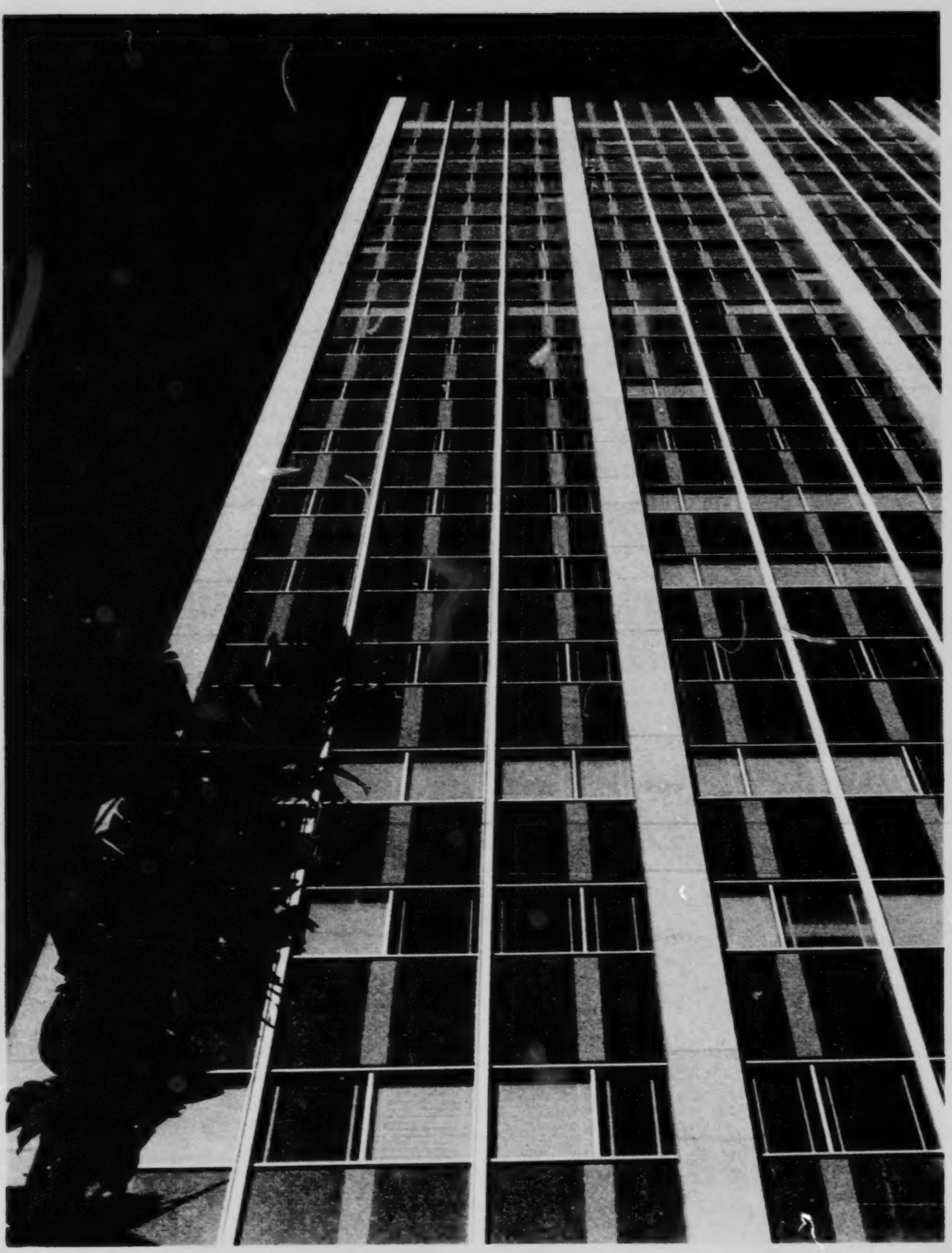

Fig. B-7. Venetian glass mosaics on the exterior of a building in Los Angeles

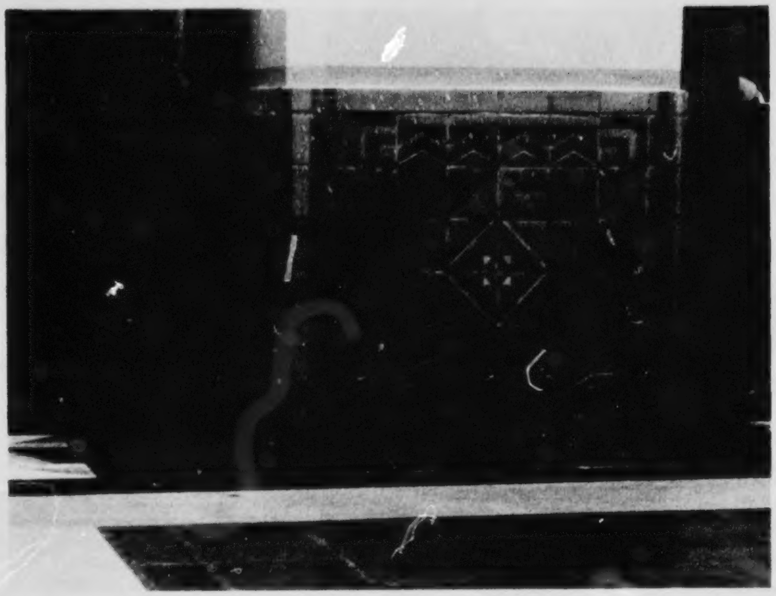

Fig. B-8. Cement body tile on the floor and faience tile around the pillars (Union Train Station in Los Angeles)

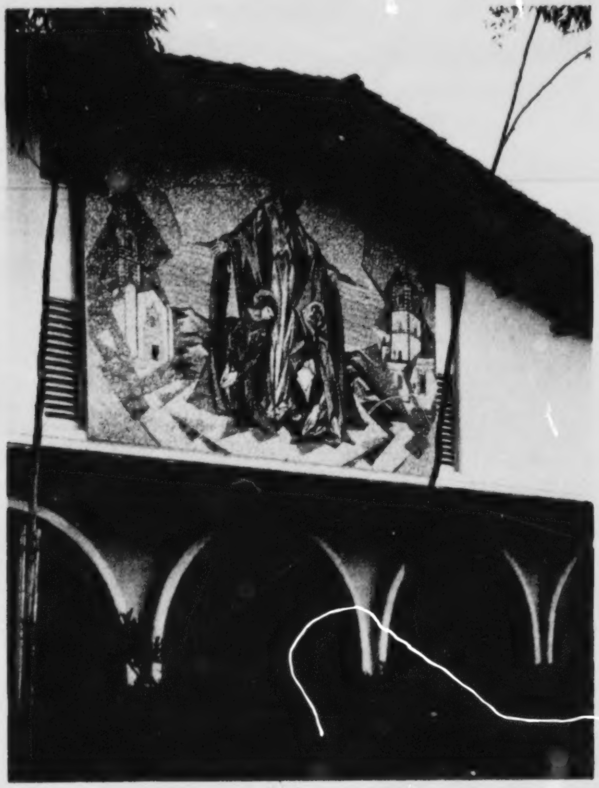

Fig. B-9. Smalti-type mosaic on St. Mary Magdalen Catholic Church, Los Angeles

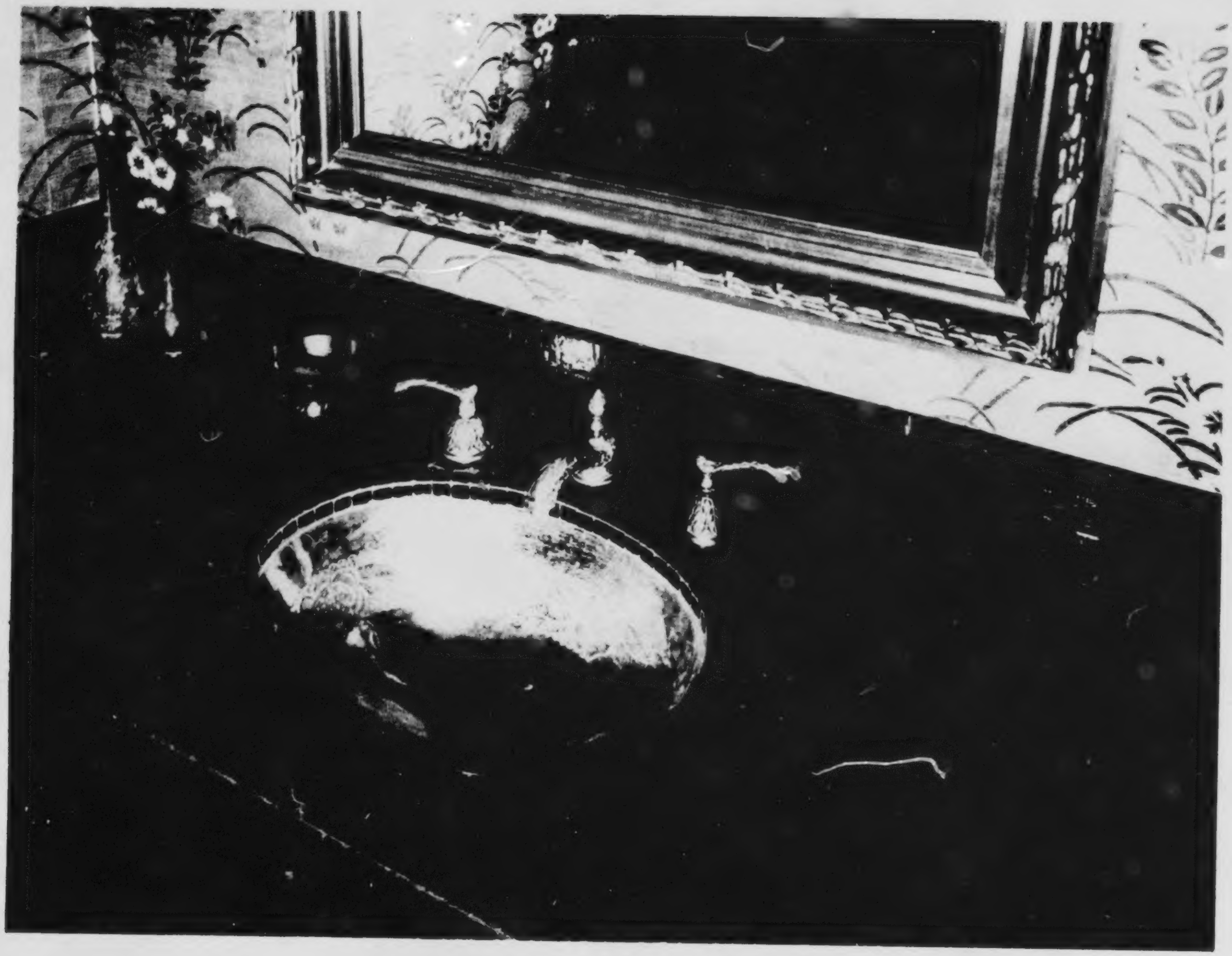

Fig. B-68. Tiled pullman

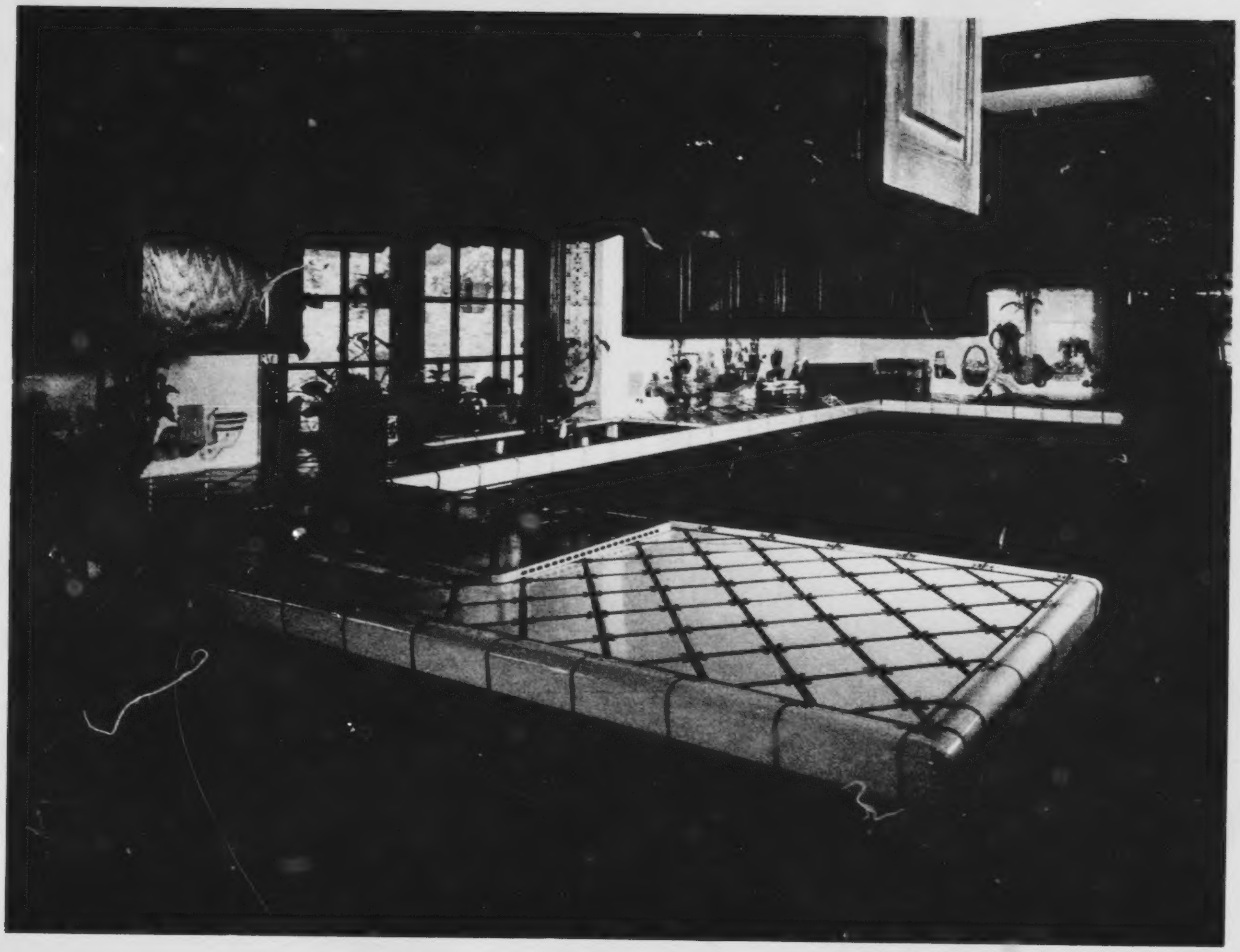

Fig. D-3. Example of a diagonal pattern for a kitchen counter

Fig. D-5. Example of a decorative pattern for a bathroom

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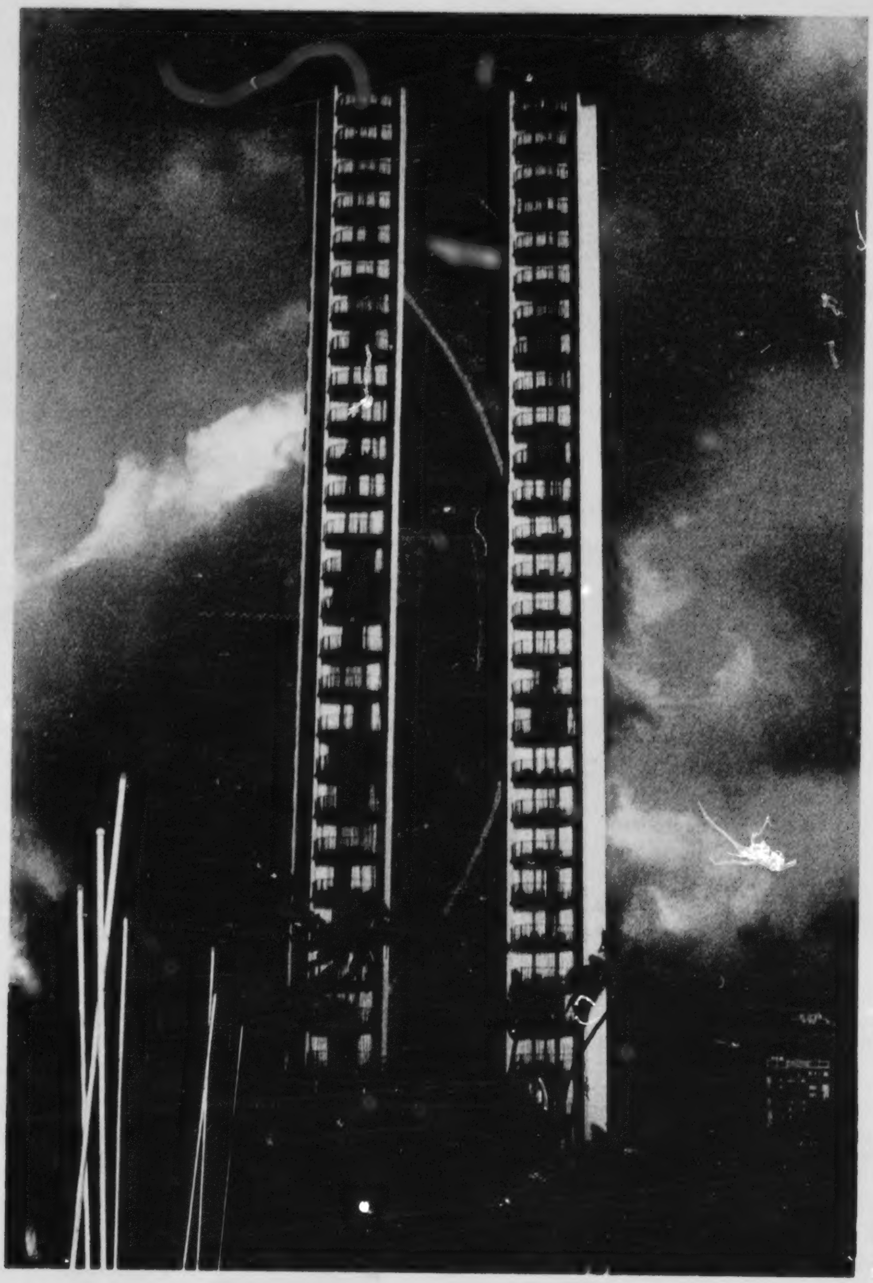

Fig. D-20. Example of a tiled vertical surface

Fig. E-15. Vaulted ceiling made with glazed ceramic tile (Los Angeles City Hall)

Fig. E-16. Vaulted arches (St. Anthony's Catholic Church, Sixth and Olive Streets, Long Beach, Calif.)

Fig. E-17. One of 14 mosaic illustrations (St. Anthony's Catholic Church, Sixth and Olive Streets, Long Beach, Calif.)

Fig. E-18. Residential pool with mosaic tile

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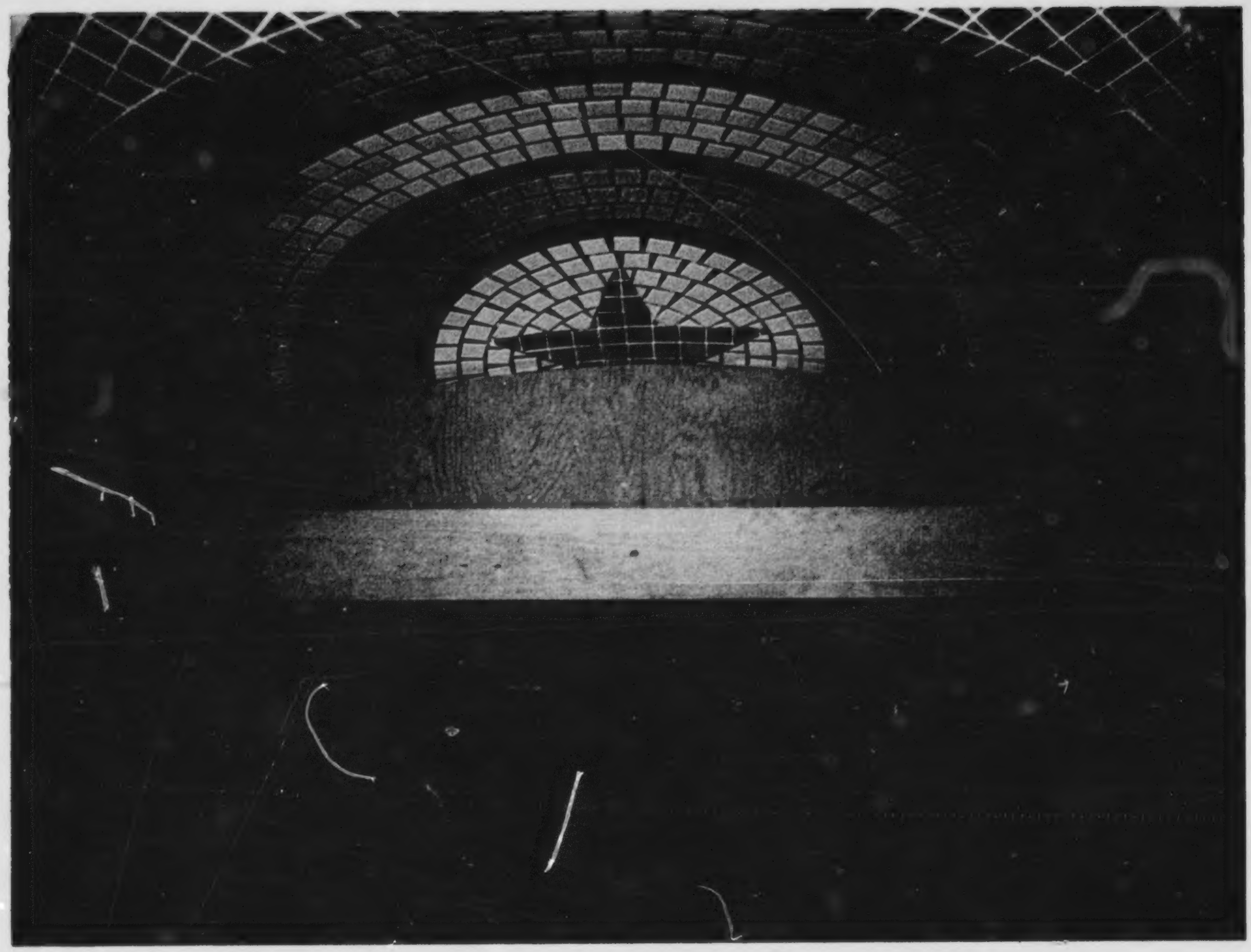

Fig. E-79. Shower dome being constructed

Fig. E-81. Example of a large dome (St. Vincent's Catholic Church, Los Angeles)

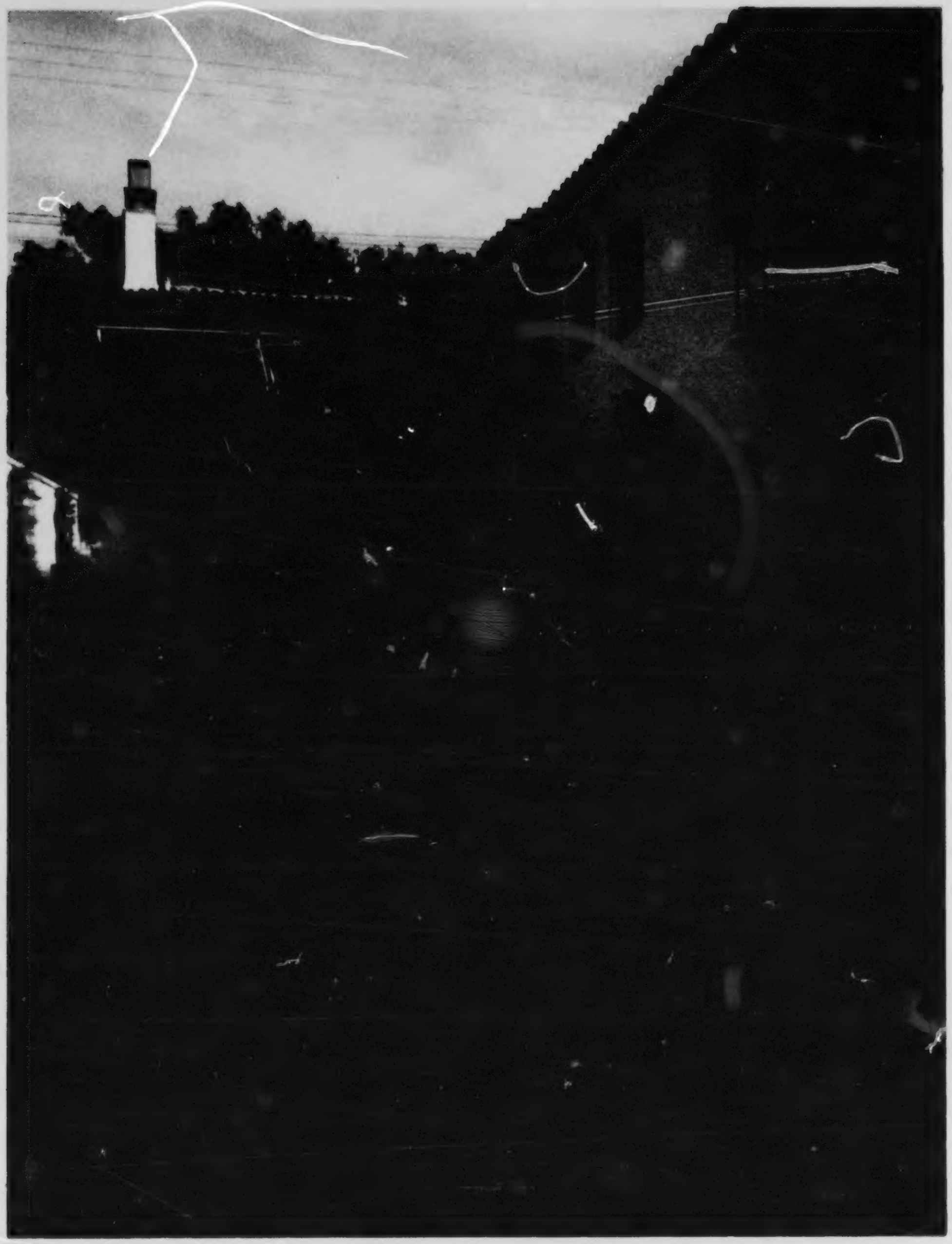

Fig. E-124. Tiled fountain (private residence)

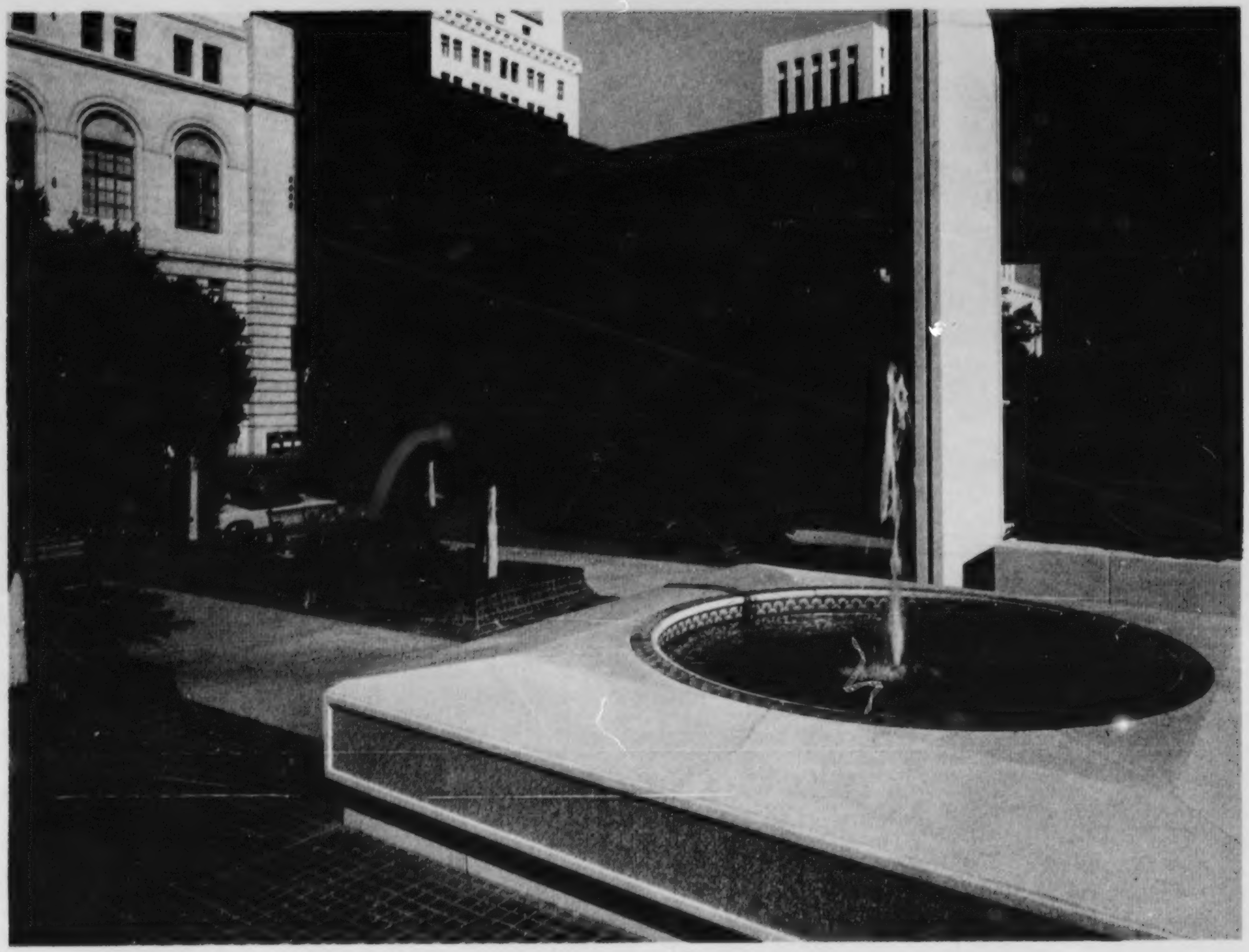

Fig. E-125. Circular fountain (Los Angeles City Mall)

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Unit E Specialized Jobs

TOPIC 1 — TILE FLOORS

This topic is planned to provide answers to the following questions:

- **What methods are used in floating floor mortar?**
- **How are quarry tile floors laid?**
- **How is quarry rack used?**
- **How are mosaic tile floors laid?**

Before tilesetters can begin to lay out a tile floor, they must check the room thoroughly to be sure that the walls are straight and parallel and are at right angles to each other. No matter how accurately a house has been built or how competent the work, building materials tend to shrink and tolerances tend to change. Few floors will be precisely square, and few walls will be precisely plumb. The tilesetter should make an accurate check of such items as door levels, floor drains, cleanouts, pitches, and toilet rings to see that all fixtures are set at the correct levels.

These precautions apply to the installation of any tile floor, regardless of the type of tile used glazed self-spaced tile, ceramic-mounted sheet, or quarry tile. The conscientious tilesetter will personally check the work site before initiating the tile layout.

The trammel bar is probably the most accurate tool that can be used for laying out tile floors. This compass is used for erecting perpendicular lines and for bisecting angles.

Floating Floor Mortar

Three methods of floating floor mortar have been developed in the trade.

Mortar Screed Method

On large floors spots of mortar can be set at intervals with a water level, transit, or taut chalk line. Stringers of mortar are spread where needed as guides for the straightedge. The mortar is tamped firmly with a wood float. A 3-inch (7.6-centimetre) section is leveled off, and the excess is eliminated on the sides. The depth of float can be determined by floating a small test section, laying a tile or sheet of tile, and beating it down with a block. Where mortar screeds are being used, extreme care must be taken not to dig below or ride above the screed. After all the mortar screeds are set, the mortar must be filled in between the screeds. While the tilesetter is floating the surface with a straightedge, he or she should tamp firmly to prevent hollow spots.

Float Strip Method

In the second method of floating floor mortar, float strips are used (Fig. E-1). This method is similar to the mortar screed method except that wood strips are placed on top of the mortar screed to give a good solid riding surface for the straightedge. The tilesetter must remember to allow for the thickness of the float strips. After the floor has been floated, the strips should be removed and the voids filled with mortar.

Prefloated Floor Method

A third method of prefloating and installing ceramic tile is illustrated in Figs. E-2 through E-9.

Laying Quarry Tile

A quarry tile floor may be laid by one of several methods. The tilesetter should always work from the longest straight wall, which is called the "master" wall.

In one method the tilesetter places "legs" consisting of single courses of tile 10 to 12 feet (3 to 3.6 metres)

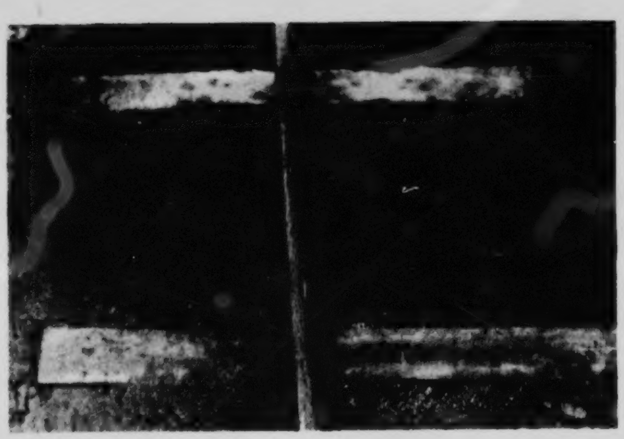


Fig. E-1. Use of float strips in floating mortar

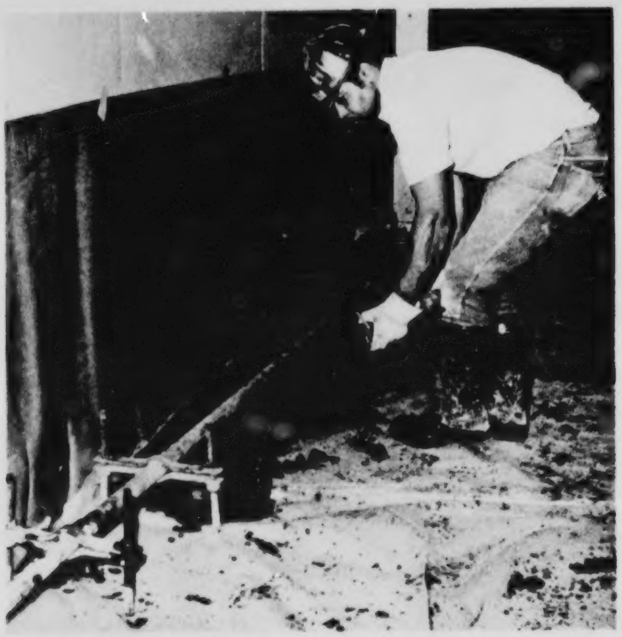


Fig. E-2. Forming the setting bed

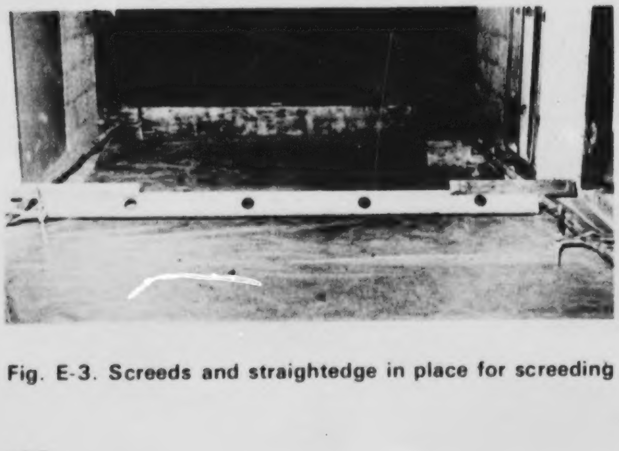


Fig. E-3. Screeds and straightedge in place for screeding

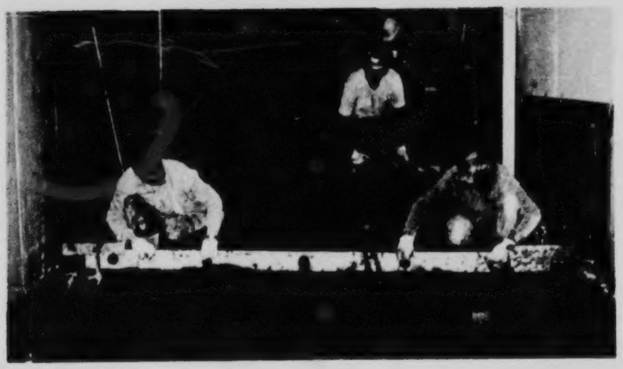


Fig. E-4. Screeding the setting bed to proper plane

Fig. E-5. Finished setting bed prior to bonding the tile

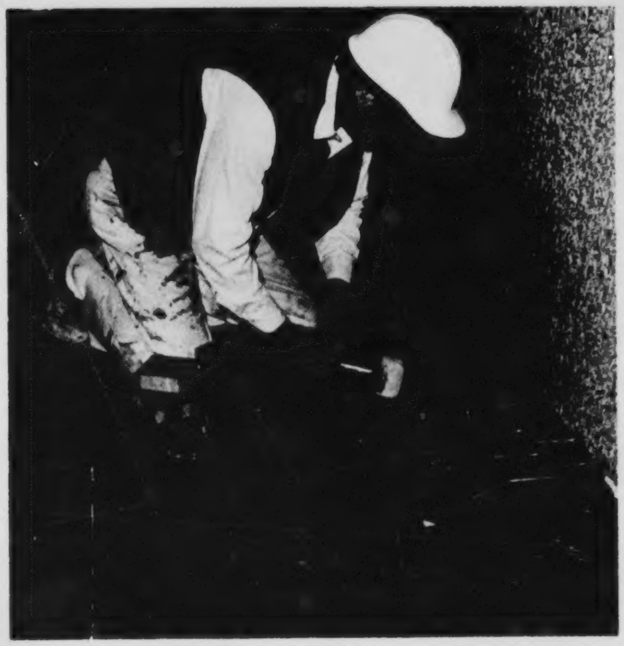


Fig. E-6. Bonding 4 by 4 by 1¼ in. (10.2 by 10.2 by 3.2 cm) ceramic paving units to setting bed

Fig. E-7. Ceramic paving units bonded in place

Fig. E-8. Filling the joints with grout

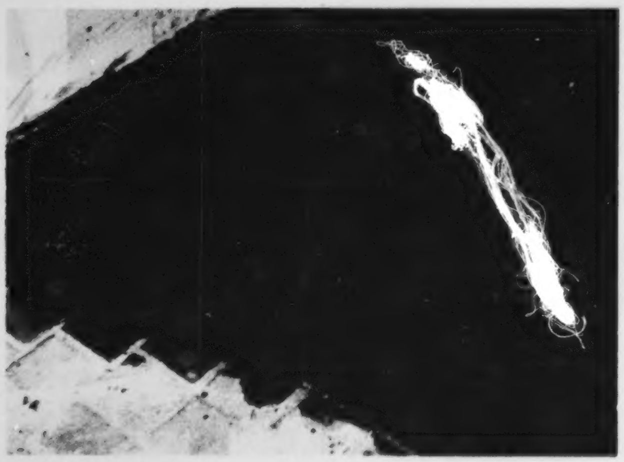


Fig. E-9. Completed paving tile with grouting

apart at right angles to the master wall and fills in the tiles between the legs.

In another method the tilesetter sets the first row against a wall at a right angle to the master wall. Then, by using a straightedge held parallel to this but three courses away, he or she fills in the intervening rows with tiles. The tilesetter continues to work three courses at a time. This method is referred to as the "without legs" method.

Using a Story Pole

A story pole, when used correctly, is the key to accurate and easy installation of tiles that require joints. A cut can be predetermined by "walking" the story pole around a wainscot or floor. One can readily see how important it is to be able to make a story pole on the job. In some cases a slight enlargement on the closing of a joint will eliminate much cutting of tiles and permit an easy layout and installation. The joint allows for any variation in the size of the tiles. The required tools are the straightedge, dividers, tape rule, combination square, and pencil. The steps, which are illustrated in Fig. E-10, are as follows:

Step 1. Determine the size of the joint to be used. In the referenced figure a ½-inch (1.3-centimetre) joint is used. Set the dividers to the size of the tile plus the width of the joint. In the referenced figure, 6 by 6 inch (15.2 by 15.2 centimetre) quarry tiles are used.

Step 2. Start at point A (using 6½-inch or 16.5-centimetre setting), and mark on a straightedge the number of spaces desired.

Step 3. Place the tile to be used at point B, and establish point C by marking the opposite side of the tile. A ½-inch (1.3-centimetre) joint should measure between point C and the end of the straightedge.

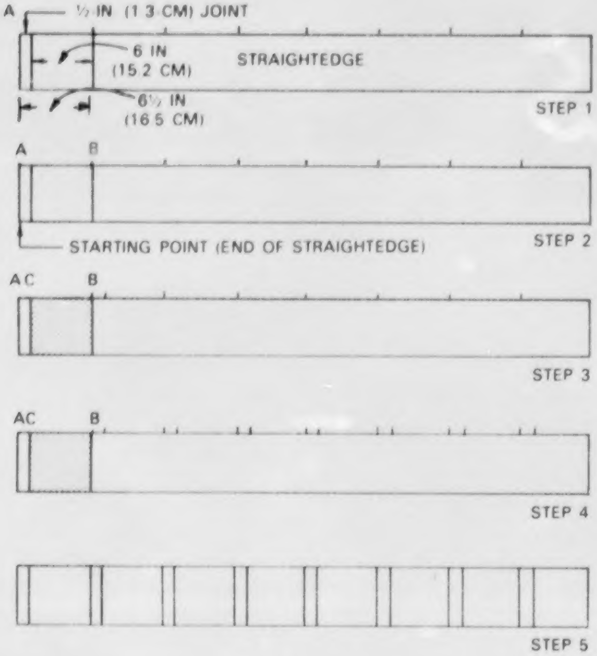


Fig. E-10. Layout of a story pole with joints

Step 4. Start at point B, and step off ½-inch (1.3-centimetre) spans beyond the previously made marks.

Step 5. Using a combination square, draw lines through the divider marks, and establish the joints on the straightedge. The story pole must have a grout joint marked on one end.

Using the "With Legs" Method

On a job where the floor is to be laid "with legs," a strip of mortar wide enough for one tile should be floated parallel to and against the master wall. The tilesetter should use the story pole to lay a row of tiles, keeping one corner of each tile against the mark on the pole. This course must be absolutely straight because the entire floor will follow this layout (Fig. E-11).

When the first row is completed, a full-length course should be laid at right angles to it, again using the story pole as a guide. A second leg is started about 10 to 12 feet (3 to 3.6 metres) from the first leg. When

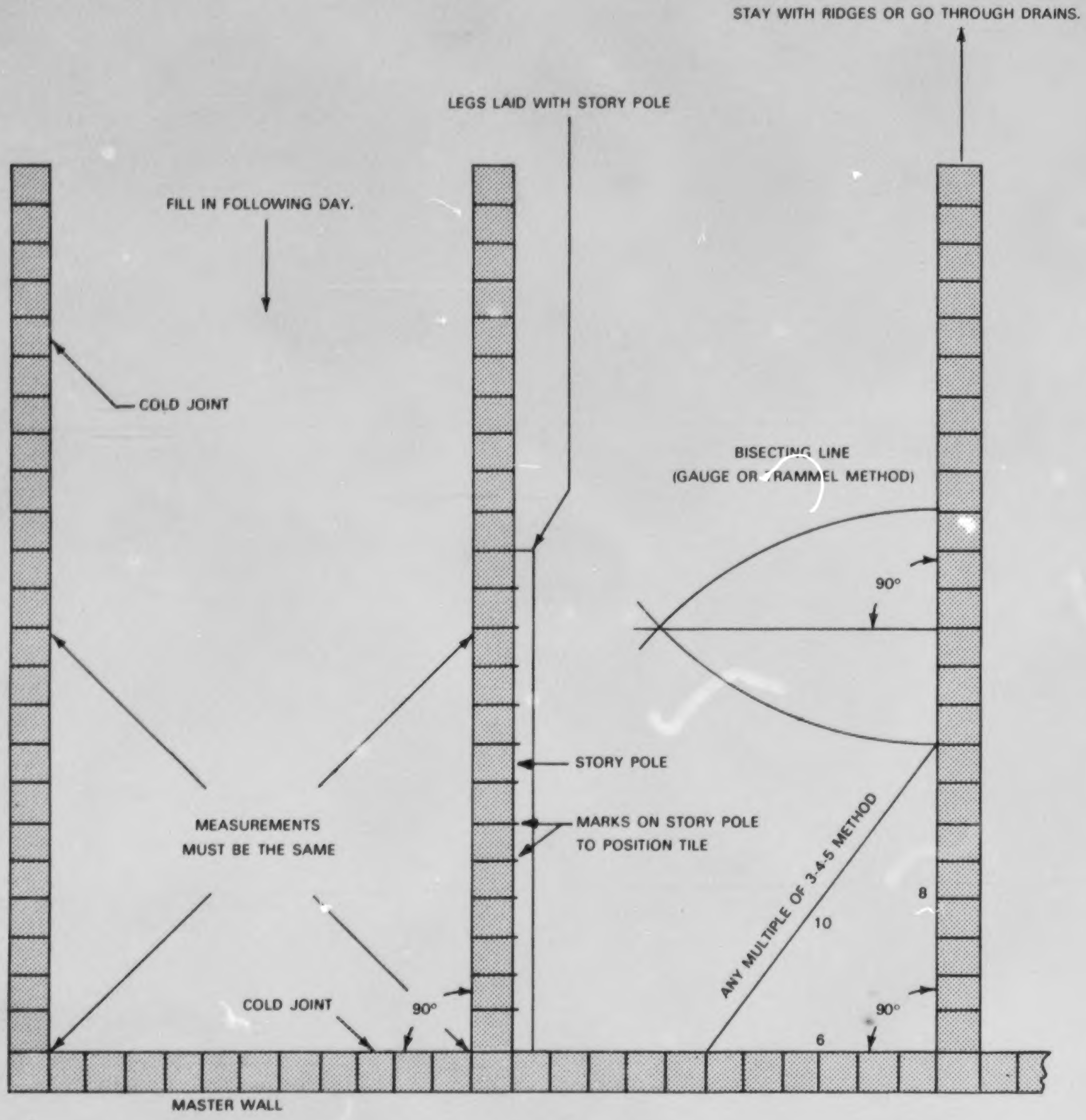

STAY WITH RIDGES OR GO THROUGH DRAINS.
LEGS LAID WITH STORY POLE
FILL IN FOLLOWING DAY.
COLD JOINT
BISECTING LINE
(GAUGE OR TRAMMEL METHOD)
90°
STORY POLE
MEASUREMENTS
MUST BE THE SAME
MARKS ON STORY POLE
TO POSITION TILE
ANY MULTIPLE OF 3-4-5 METHOD
8
10
COLD JOINT
90°
90°
6
MASTER WALL

Fig. E-11. Layout of quarry floor "with legs" necessary, the tiles can be laid along the ridges or through drains. For large floors additional legs may be laid with the story pole.

Throughout the work, each tile is set with the same corner on the story pole mark, even though the joints between the tiles may change with the varying size of the tiles.

When all the legs have been set, the remainder of the tiles are filled in, using the straightedge and working toward the floor as laid out by the legs.

Using the "Without Legs" Method

If the tile floor is to be laid "without legs," the tilesetter will need, in addition to the straightedge story pole, two short layout sticks each as long as three tiles plus three joints (Fig. E-12). Both sticks should be cut at the same time with one saw cut to ensure a uniform length.

The procedure for laying a floor "without legs" is as follows:

1. Set a chalk line or string parallel to the wall at a point one tile width from the longest wall. This line must be kept taut and free from the floor.
2. Set the end of the straightedge against the longest wall, and hold it perpendicular to the wall. A nail should be inserted at a point where the straightedge crosses the chalk line. The nail serves as a guide for the straightedge.
3. Keep the straightedge perpendicular to the longest wall (with the guide nail on the chalk line), and lay one row of tile against the straightedge.
4. Use the two layout sticks to move the straightedge back three rows, keeping the guide nail on the chalk line.
5. Lay another row of tile to the straightedge. Fill in by eye the two rows between this row and the first row laid.
6. Straighten and beat in the tile where needed.
7. Repeat the entire process, working away from the finished wall.

Using a Quarry Rack

The tilesetter can use a quarry rack to lay quarry tile. This device is used as follows:

1. Begin at the longest wall, and set a chalk line parallel to the wall. The distance from the wall should be equal to the rack width plus one tile and joint.
2. Set rack parallel to line at a proper point from adjacent wall.
3. Butt all tiles toward the same corner of the rack, and point them toward the same corner of the room or building.
4. Tap tiles in place.
5. Lift rack straight up, and set it in a new position. Always check for correct joint spacing between the rack edges and the installed tiles. Make all joints even.
6. Check the quarry rack to ensure that it is always square.

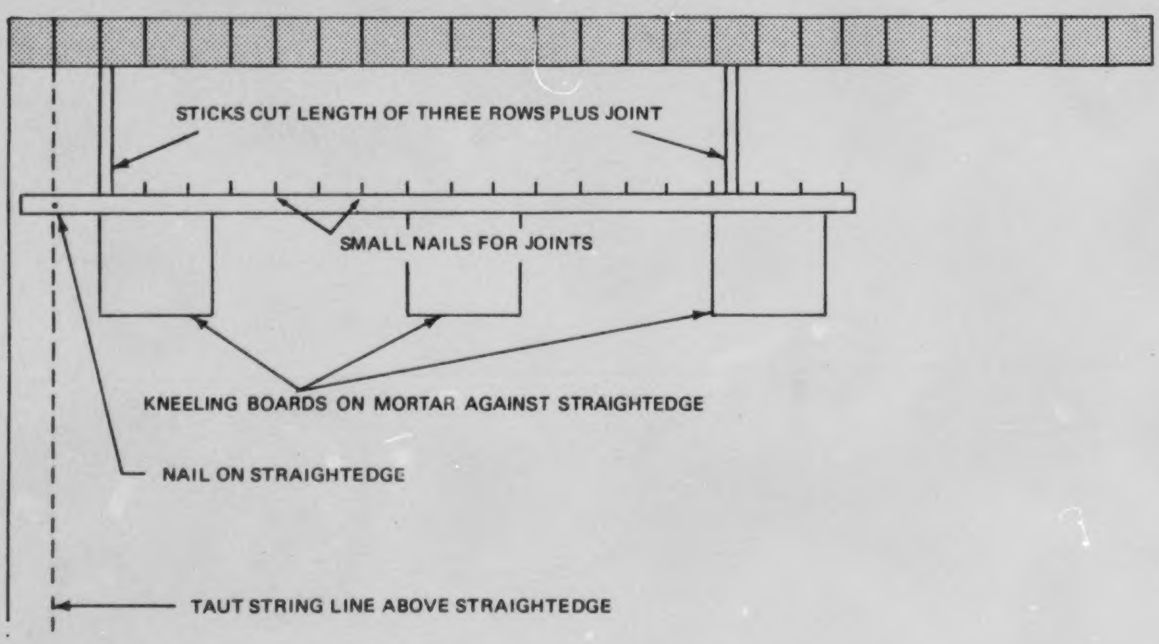

STICKS CUT LENGTH OF THREE ROWS PLUS JOINT
SMALL NAILS FOR JOINTS
KNEELING BOARDS ON MORTAR AGAINST STRAIGHTEDGE
NAIL ON STRAIGHTEDGE
TAUT STRING LINE ABOVE STRAIGHTEDGE

Fig. E-12. Layout of quarry floor "without legs"

Laying Ceramic Mosaic Tile

To lay a ceramic mosaic tile floor, the tilesetter should use the following method:

1. Begin at the intersection of the two longest right-angle walls, and dust a section with dry cement to cover the mortar lightly. The mortar should be just wet enough to saturate the dry cement from below. If the mortar is too dry, it may have to be sprinkled with water.
2. Lay a small section of tile, and beat it down with a flat block. This beating should ensure a good bond and make the tile smooth and level.
3. Place a kneeling board on this section, and continue laying the tile floor. When using a kneeling board, exercise caution, especially on floors with drains, to avoid causing an indentation on the floor. Do not use kneeling boards that are more than 12 inches (30.5 centimetres) wide. Place the boards so they run in the direction of the slope, rather than across it. Also, be sure no chips of tile or other material that could cause an indentation on the floor are under the board. Always avoid kneeling or standing on the edge of the board, because doing so could leave marks on the floor.

The tilesetter should keep the same size joint between the ends of the sheets as between the tiles in the mounted sheet. When the floor is laid and the tiles are beaten in correctly, the sheet should be dampened to soften the paste holding the tiles to the paper; then, the paper should be pulled off slowly. A mixture of screen-graded sand and cement "half and half" is swept in. The installation is completed by beating and rubbing the tile floor. Each section should be cleaned as it is completed (Fig. E-13).

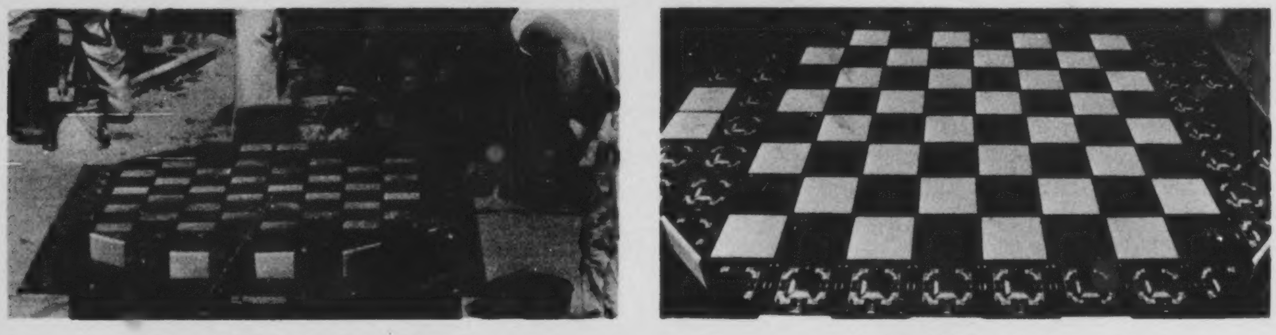
Using Latex or Thin-Set Mortar

When the thin-set method is to be used to bond ceramic mosaic tile directly to a concrete slab, sufficient thin-set or latex-type portland cement bonding material must be provided. In accordance with ANSI Specification A108.5, the thickness of the bonding mortar should be at least $\frac{3}{32}$ inch (0.2 centimetre) without voids. The grooves left by the teeth of the trowel must be filled in.

Both kinds of mortar should be mixed by hand or in a device that will not whip it full of air bubbles. When it is whipped full of air, the strength is drastically reduced.

Experience has proved that the bond strength of thin-set portland cement bonding mortar is greatly improved when it is covered and cured for at least 72 hours.

After the completed tilework is grouted, it must be covered to achieve a hard, dense, well-cured grout. This is one of the most important steps in a successful installation.



BEFORE FINAL CLEANING

AFTER FINAL CLEANING

Fig. E-13. Cleaning the completed installation

UNIT E — SPECIALIZED JOBS

TOPIC 1 — TILE FLOORS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Extreme caution must be taken not to dig below or ride above the mortar ___1___. 1. ________

2. In the mortar screed method of floating floor mortar, the depth of float can be determined by floating a small ___2___ section. 2. ________

3. Before a tile floor is laid, the room should be checked to see that the walls are straight and ___3___. 3. ________

4. The filled-in mortar is tamped to prevent ___4___ spots. 4. ________

5. The longest straight wall in a room is referred to as the ___5___ wall. 5. ________

6. After the floor is floated, the strips are ___6___. 6. ________

7. To make a story pole, the tilesetter should mark a straightedge along its entire length at intervals of one ___7___ plus one joint. 7. ________

8. The story pole should have a(n) ___8___ joint marked on one end. 8. ________

9. When thin-set portland cement mortar is used to bond ceramic mosaic tile directly to concrete, the thickness of the mortar should be ___9___ inch(es). 9. ________

10. After the completed tilework is grouted, it should be ___10___. 10. ________

UNIT E — SPECIALIZED JOBS

TOPIC 2 — STEAM ROOMS

This topic is planned to provide answers to the following questions:

- **What special tiling features are required in a steam room?**
- **How are control joints established?**
- **How is drainage provided in a steam room?**

The steam rooms in athletic clubs and gymnasiums have been used for many years as places for conditioning the body. Steam generally is formed in the room by spraying water on a hot surface, such as rocks or metal cones that have been heated by a gas burner. Because of the constant high temperature and high moisture content of the air, the surfaces of these rooms must be waterproof. A well-installed tile job on the surface of the walls, floor, and ceiling of a steam room will enhance its beauty as well as its water resistance.

Special Conditions

Steam has a high penetrating power. Therefore, the walls and floors of all steam rooms should be hot-mopped before the tilework is started. This treatment prevents moisture from penetrating wooden structures, such as wood studs and ceiling joists. To prevent puncturing of the hot-mopped surfaces, the installers should use wire pigtails to attach the reinforcing wire to the wall surface. The tilesetter should inspect the surface to see that these precautions have been taken.

Control Joints

Control (expansion) joints of an approved type must be used at intervals on the walls. The joints must extend through the mortar. The tile at the bottom of the walls must be set high to allow the floor tile to be installed under the wall; or, if a cove is used, the floor must be kept away from the cove base. The joint between the wall and the floor should be similar to that shown in Fig. E-14. It should be filled with caulking compound. The ceiling should be laid on top of the wall tile. This should allow for the expansion or contraction of the ceiling tile.

Drainage

Steam rooms must have a pitched ceiling to prevent the condensed moisture from dripping. Benches should have a good slope to drain the water, and the floor should have a constant pitch throughout, reaching to the drain. The outline of a steam room is shown in Fig. E-14. The pitched ceiling, benches, and floor are indicated in the outline.

To the Instructor

Additional information on tiling steam rooms is contained in the *Handbook for Ceramic Tile Installation.* (See list of instructional materials at end of this workbook.)

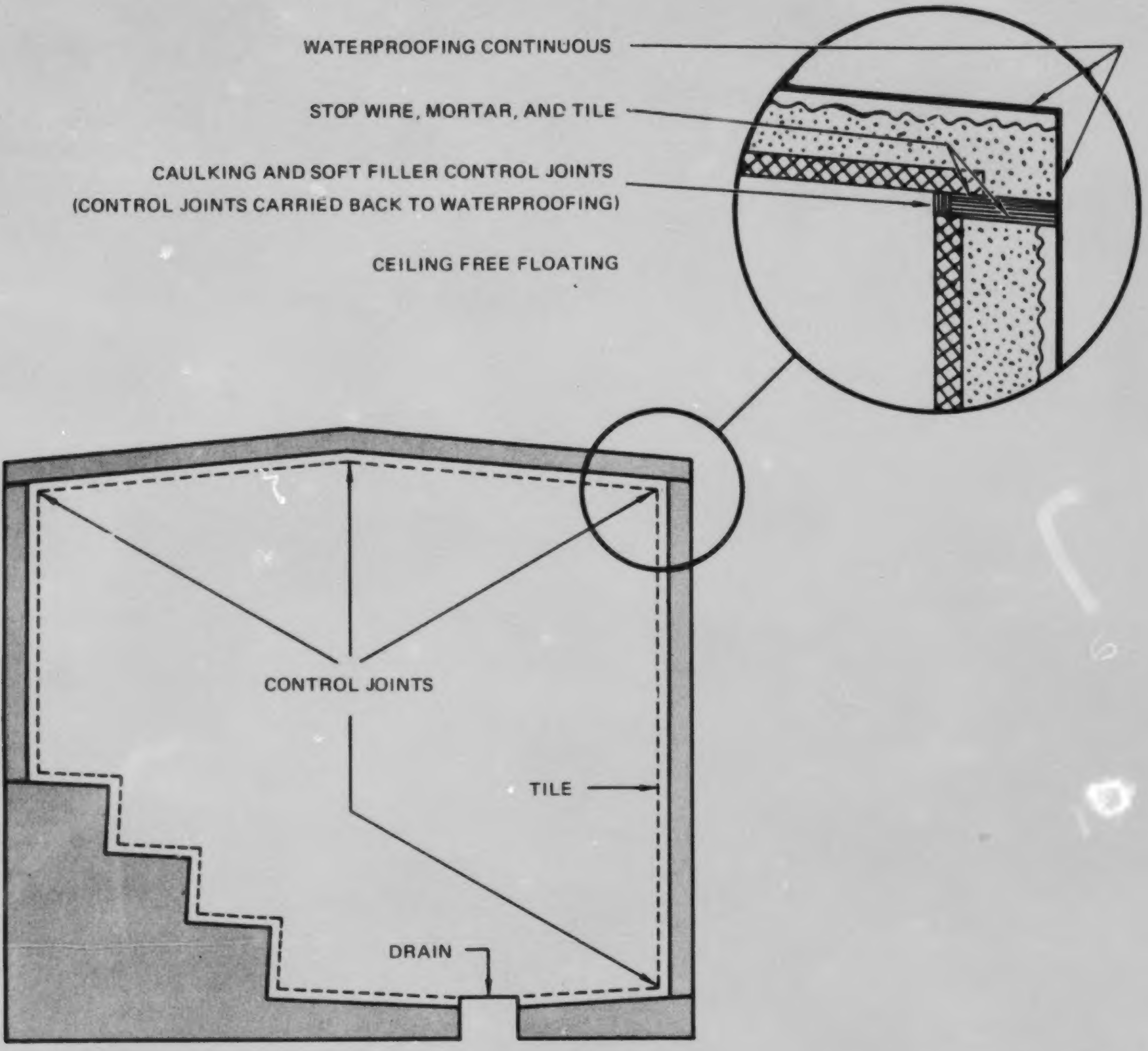

WATERPROOFING CONTINUOUS
STOP WIRE, MORTAR, AND TILE
CAULKING AND SOFT FILLER CONTROL JOINTS
(CONTROL JOINTS CARRIED BACK TO WATERPROOFING)
CEILING FREE FLOATING
CONTROL JOINTS
TILE
DRAIN

Fig. E-14. Outline of steam room

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UNIT E — SPECIALIZED JOBS

TOPIC 2 — STEAM ROOMS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The floor of a steam room should have a(n) 1 2 for drainage. 1. ________ 2. ________

2. All wood studs, ceiling joints, and other wood in the walls and floors of a steam room should be 3 - 4 before tile is applied. 3. ________ 4. ________

3. Because of the high moisture content, the surfaces of the steam room should be 5. 5. ________

4. To prevent the dripping of condensed moisture, steam rooms should have 6 ceilings. 6. ________

5. To allow for possible expansion, the ceiling should be free floating and separate from the 7 8. 7. ________ 8. ________

6. Control 9 of an approved type must be used on the walls. 9. ________

7. A special heat-resistant cement is used on the walls behind the 10 11. 10. ________ 11. ________

8. When the special conditions for steam rooms are met, 12 can be applied in the usual manner to the walls, the ceiling, and the floor. 12. ________

9. Joints between the floor and the wall should be thoroughly 13. 13. ________

10. The tilesetter must check to see that 14 15 are provided through the hot-mopped wall surfaces for fastening the reinforcing wire. 14. ________ 15. ________

TOPIC 3 — CEILINGS

This topic is planned to provide answers to the following questions:

- **How is a ceiling laid out?**
- **How is ceiling mortar applied?**
- **How are ceiling tiles installed?**

Because gravity works directly against the tilesetter during the installation of tile on a ceiling, the difference between setting ceilings and other horizontal surfaces is significant. Heavy applications of mortar for ceiling installations should be avoided; however, the most important thing to remember in ceiling work is to control the amount of water in the mortar. Gravity will draw this water down to the surface while the tilesetter is working below. Thus, too much water will make the work difficult or impossible, but sufficient water must be used to cure the mortar and the cement and to provide an adequate bond between the tile and the mortar.

Each application of mortar should be well bonded to the preceding one. Each coat of mortar should be scratched deeply in two directions, and each additional coat should be troweled firmly into the preceding one.

Layout of Ceiling

To complete the layout of ceiling tile, the tilesetter should do the following:

1. Determine whether the ceiling is to be installed before or after the walls are in place. Usually, the walls are installed first; however, the type of tile going on the walls must be considered. The tile should be laid out so that the ceiling does not butt to a wall that has beveled, reeded, or other irregularly shaped tiles.
2. Square or parallel one wall to the general area; and square the intersecting, adjacent, and return walls in order to line up the tile walls to the ceiling.
3. Do all layout, centering of walls, and determination of the size of cuts prior to setting the tile. Tiles should not be moved after they have once been placed and set. The bond is easily broken when tiles are moved after the initial set.
4. Determine where control joints will be placed, and provide for them in advance. These joints are filled with a suitable caulking compound after all other work is completed. Always leave the space between walls and ceiling open and clear. This space is also filled with caulking compound.

Installation of Tile

Ceilings should be separate in themselves and should be as "free floating" as possible. The reinforcing wire or metal lath should not be turned down around the perimeter of the ceiling. Likewise, mortar and tiles should be kept free from resting on or butting against walls.

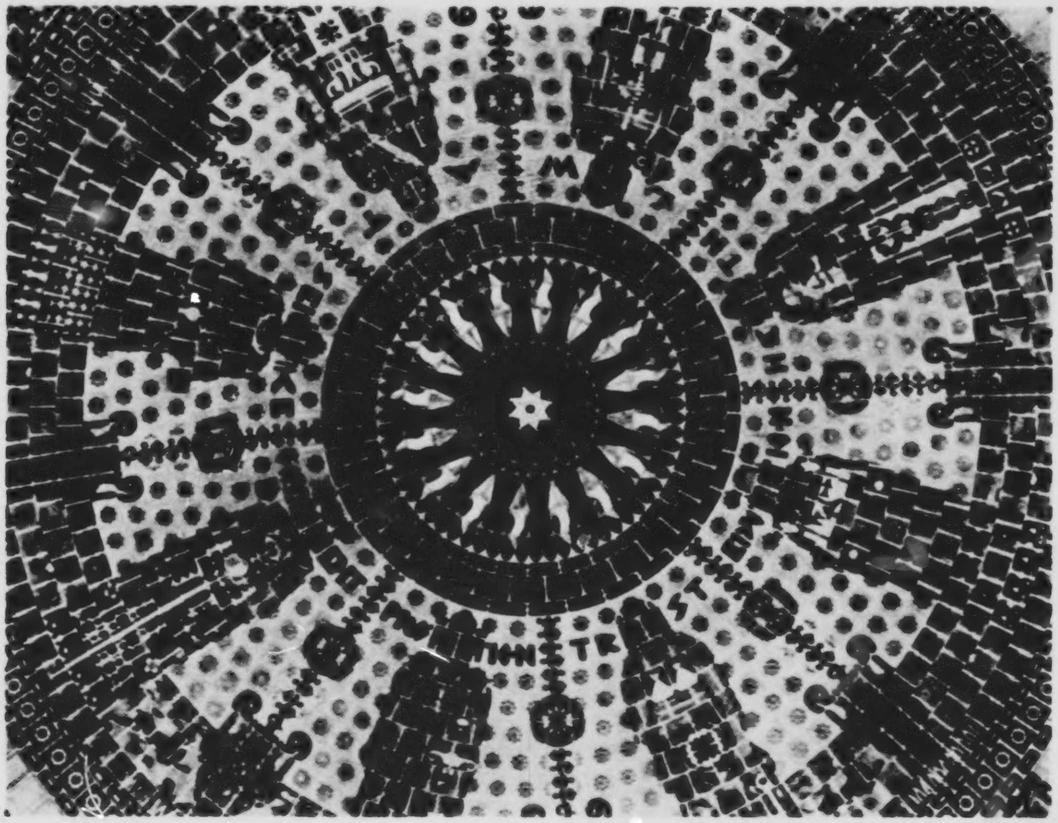
Ceramic mosaic and other types of tiles may be applied to ceilings (Fig. E-15). Each type requires special techniques, but the basic methods of installation remain the same. The steps used in setting tile on ceilings are as follows:

1. Establish the correct plane to which mortar is to be floated by (1) leaving spots of mortar to harden prior to floating; (2) leaving screeds of mortar to harden before floating; or (3) running a notched straightedge along the top row of wall tile.
2. Apply the float coat in either one or two coats. If it is to be applied in one coat, leave the mortar to harden several hours or overnight before setting tile. If it is to be applied in two operations, apply one coat to a true and level plane, leaving room for a thin coat to follow. Let the first coat set overnight. Apply the second coat, and place the tiles while the mortar is still in a plastic state.
3. Soak glazed tiles for at least 30 minutes before setting them when pure cement is being used for the bond coat. The tiles should be allowed to drain well before they are set in place.
4. Use one of the following two methods, or a combination of the two, for the pure coat: (1) apply the pure cement $1/16$ inch (0.2 centimetre) thick to the back of each tile before setting it in place; or (2) spread pure cement $1/16$ inch (0.2 centimetre) thick directly on the mortar with a trowel. Make sure not to spread the pure cement on more than four courses at any one time, and use a scratcher lightly to ensure a good bond. Tap each tile into the mortar, and lightly beat in each tile with a beating block. If the cement is applied to the back of the tiles, notch the pure cement or circle butter. If the cement is applied to the mortar bed, scratch the pure coat with a sharp scratcher (scarifier). Either of these methods will allow for

the escape of trapped air and excess water, thus producing a better bond.

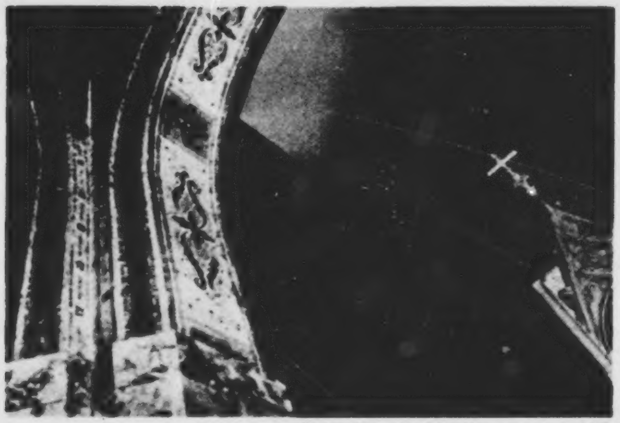
5. Use care in placing tile; the bond may be broken if tiles are moved.
6. Clean up the tile after application, using water sparingly. Leave the grouting to be done the following day.

Two beautiful examples of mosaic tilework are shown in Figs. E-16 and E-17.



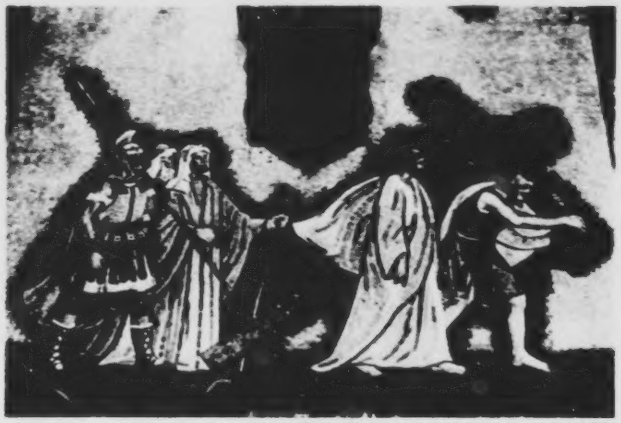
See color reproduction on page 128.

Fig. E-15. Vaulted ceiling made with glazed ceramic tile (Los Angeles City Hall)



See color reproduction on page 129.

Fig. E-16. Vaulted arches (St. Anthony's Catholic Church, Sixth and Olive Streets, Long Beach, Calif.)



See color reproduction on page 129.

Fig. E-17. One of 14 mosaic illustrations (St. Anthony's Catholic Church, Sixth and Olive Streets, Long Beach, Calif.)

UNIT E — SPECIALIZED JOBS

TOPIC 3 — CEILINGS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. For ceiling installations, the applications of mortar should be 1. 1. ________
2. Generally, tile is installed on the 2 before it is installed on the ceiling. 2. ________
3. Controlling the amount of 3 in the mortar is particularly important in ceiling work. 3. ________
4. If pure cement is buttered on each tile, it should be 4 thick. 4. ________
5. Glazed tile should be soaked for at least 5 hour(s). 5. ________
6. The pure cement should not be spread on more than 6 courses at one time. 6. ________
7. When it is applied to the back of tiles, pure cement should be 7. 7. ________
8. When mortar is floated to the desired plane in two coats, the 8 coat should stand overnight before the tile is applied. 8. ________
9. Wire reinforcing or metal lath should not be turned down around the 9 of the ceiling. 9. ________
10. Ceilings that are not butted to or resting on the walls are said to be 10 floating. 10. ________

TOPIC 4 — GLASS AND MARBLE MOSAICS

This topic is planned to provide answers to the following questions:

- **How is the setting bed prepared for mosaic tilework?**
- **How are mosaic tiles set in place?**
- **How are colored grouts prepared?**

Correctly installed mosaic tiles, whether of glass or marble, contribute much to the decor and beauty of a tiled area (Fig. E-18). Apprentice tilesetters should acquire an adequate knowledge of setting mosaic tiles if they study this topic carefully.

The same procedure is followed in setting both glass and marble mosaics; however, because these mosaics are composed of many stones in a sheet, tilesetters must use particular care in working with them.

Handling the Tile

Glass and marble mosaics should be handled with the utmost care. Sheets should be moved with the paper side down. When a sheet is picked up, it should be grasped by opposite corners and lifted on a level plane. The stones may drop out if the sheets are carried incorrectly.

Planning the Layout

A mosaic floor, such as the one shown in Fig. E-19, can be laid out as follows:

1. Use a dry place that is near enough to the job installation and large enough to loft the complete mosaic. (Beware of damp cement floors.)
2. Starting with sheet No. 1, lay out the mosaic in accordance with the master plan, keeping each sheet as tight as possible.
3. When the last sheet is in place, measure the mosaic for length and width to see that it fits the area to be installed.

Preparing the Setting Bed

The setting bed can be prepared by (1) using float strips or hard screeds and floating in the usual manner; or (2) using a flat trowel and a small straightedge for a freehand float. The second method, which allows for certain desired variations, is specified by most architects.

Buttering the Tile

When the setting bed is ready to receive the mosaic, the center and parallel lines should be scribed. Supporting screeds or bridges may be necessary.

The buttering mortar for smalti and marble mosaics should be prepared and applied as follows:

1. Prepare a dry mixture, using four parts fine screened sand, one part cement, and one part hydrated lime. Mix to a soft mortar consistency.
2. Beginning with sheet No. 2 from the master layout, place it paper side down on a clean, dry mortarboard. Apply the fine mortar mix to the back of the sheet around the stones with a gauging trowel, using sidewise motion. Press down firmly. (Because of the shape of the area and the

See color reproduction on page 130.

Fig. E-18. Residential pool with mosaic tile

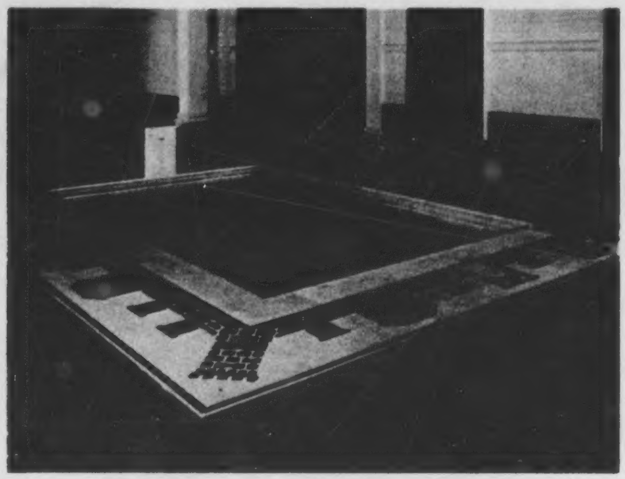


Fig. E-19. Marble-mosaic floor (J. Paul Getty Museum, Los Angeles)

design, certain jobs require starting from the centerline and working both ways.)

3. Never lift the trowel straight up, because some of the stones may lift also.
4. Trowel to a uniform thickness. The thickest stone should be used as the gauge. The stones should be locked in place.

The buttering cement for molded and pressed glass mosaics should be prepared with one part fine screened sand and two parts portland cement. Lime should not be used.

Setting the Tile

The sheets of smalti mosaic tile should be installed as follows:

1. Apply a thin coat of pure cement to the setting bed.
2. Lift the sheet so that the design is right side up, and wipe away excess mortar from all edges.
3. Place the sheet in position on the installation, with the stone side toward the setting bed.
4. Tap the sheet lightly to the surface coated with pure cement. (Use a small beating block.) Wipe off the mortarboard, and continue with the rest of the sheets in the same manner.
5. Begin to wet the paper with a brush or a sprayer after ten or more sheets have been laid.
6. Beat the sheet once again with a block and hammer. Continue until all sheets have been laid and dampened.
7. When the paper is thoroughly soaked, peel it away carefully, keeping the hands as close as possible to the tiles so that no tiles will be lifted out.
8. Scrub the surface with a stiff brush, and sponge it to remove excess paste or glue. Use fine mortar to fill ungrouted joints.
9. Sponge once again, and replace any lost stones.
10. Wait three days, and clean with one part muriatic acid in nine to ten parts of water. Protect metal or other materials prior to acid cleaning.

A soft brush should be used to clean glass mosaic other than smalti mosaic. After the mosaic is set, it should be scrubbed with an abrasive nylon pad and given a light acid cleaning. (The formula used for light acid cleaning is 20 parts of water to one part of muriatic acid.)

Applying Colored Grout

A colored grout is obtained by (1) mixing the dry color with water and applying the mixture on a thoroughly clean, dry mosaic (wiping down with a clean cloth); or (2) mixing the dry color with the fine mortar and applying the mixture to the sheets (grouting with the same mortar and sponging off and cleaning with a light acid).

Using the Box Screed Method

The box screed method is used when necessary to ensure uniform thickness for the mosaics. Short wooden strips should be used on two sides of the sheets. A fine mortar should be spread on the back of the sheets and rodded off lightly (Fig. E-20).

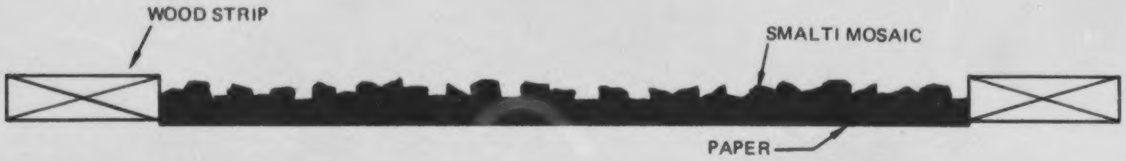


Fig. E-20. Box screed method of laying mosaic tile

UNIT E — SPECIALIZED JOBS

TOPIC 4 — GLASS AND MARBLE MOSAICS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. A colored grout mixed with _1_ may be applied on clean, dry mosaic. 1. ________

2. A dry mixture for buttering smalti mosaics is prepared in the proportion of _2_ part(s) fine screened sand, _3_ part(s) cement, and one part lime. 2. ________ 3. ________

3. Each mosaic sheet is handled by grasping it on _4_ corners and lifting it on a level plane. 4. ________

4. Mosaic sheets should always be handled with the _5_ side down. 5. ________

5. Mosaic sheets should be laid out in a(n) _6_ place. 6. ________

6. The mosaic sheet is placed in position in accordance with the _7_ _8_. 7. ________ 8. ________

7. When the last sheet is lofted, the mosaic is measured for _9_ and _10_. 9. ________ 10. ________

8. The formula for light acid cleaning is _11_ part(s) water to _12_ part(s) muriatic acid. 11. ________ 12. ________

9. The tilesetter should wait _13_ days before cleaning a smalti mosaic installation. 13. ________

10. The mix used in buttering molded and pressed glass mosaics consists of _14_ part(s) fine screened sand and _15_ part(s) portland cement. 14. ________ 15. ________

TOPIC 5 — CERAMIC VENEER

This topic is planned to provide answers to the following questions:

- **Where is ceramic veneer tile used.**
- **How is ceramic veneer tile laid out?**
- **How is ceramic veneer tile installed?**

Ceramic veneer tiles are used to relieve the monotony of unbroken wall surfaces. The color, form, and texture of veneer tiles offer infinite architectural possibilities in store fronts and corridors. A proficient tilesetter can contribute to the fine appearance of this type of architectural design.

Layout of Ceramic Veneer

Layout is extremely important in working with ceramic veneer because of the need to allow for certain fixed points in the working area, such as door heights, openings, and window sills. Ceramic veneer can be machine-cut with a portable saw or hand-cut with a pitching tool. Ceramic veneer should be laid out as follows:

1. Study the shop or architect's plans.
2. Lay a series of tiles in a straight line on a flat surface.
3. Determine the joint size in accordance with the layout. If more than one size of tiles is available, lay the smaller ones against the larger to determine the joint size of the larger tiles (Fig. E-21).

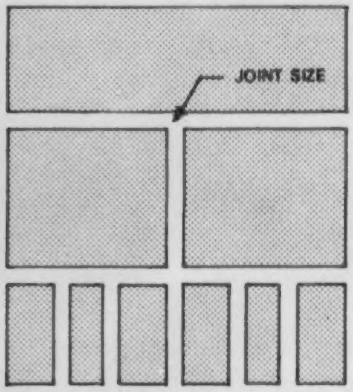


Fig. E-21. Joint size in layout

4. Mark the joint size on a long strip of wood. This strip of wood then can be used as a story pole.

Installation of Ceramic Veneer

The tiles should be soaked in clean water. Before the mortar surface is floated, the thickness of the setting bed is determined by allowing for the thickest tiles plus ¼ inch (0.6 centimetre) for the buttering mud. The tilesetter should then proceed as follows:

1. Use the story pole as a guide to scribe horizontal and vertical lines on the setting bed. This procedure will keep the work parallel and accurate.
2. To compensate for the lack of uniform thickness, place the tile face down on a butter board that has guide strips ¼ inch (0.6 centimetre) higher than the thickest tile. Apply a coat of neat cement with a trowel or brush to the back of the tile (Fig. E-22).

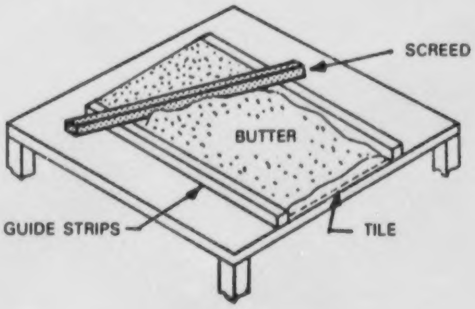


Fig. E-22. Butter board used to install veneer

3. Over the neat cement apply the buttering mortar thick enough to come up to the top of the guide strips at a uniform height. Screed the mortar to the strips.
4. Set the tiles on the setting bed, and tap them to a true surface with a rubber mallet. Check the alignment with a straightedge.

Another method that can be used to install veneer tiles is to adjust the top edge of the tiles to a true line by inserting wood wedges in the horizontal joint between the top of a row and the bottom of the row above. The wedges can be made by splitting them from a 2-inch (5-centimetre) wood block cut from the end of a board (Fig. E-23).

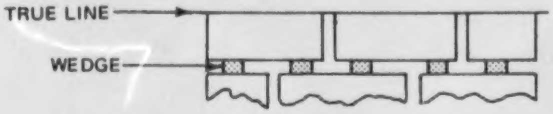


Fig. E-23. Wood wedges used to install veneer

TOPIC 5 — CERAMIC VENEER

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Because of the need to allow for certain fixed points on the walls, __1__ is extremely important in setting ceramic veneer. 1. ________

2. Veneer may be cut with a portable electric saw or a(n) __2__ __3__. 2. ________ 3. ________

3. After ceramic veneer tiles are set, the surface should be checked with a(n) __4__. 4. ________

4. The veneer tiles are laid out on a(n) __5__ surface. 5. ________

5. When the setting bed is completed, the story pole is used to __6__ horizontal or vertical lines. 6. ________

6. A coat of __7__ __8__ is applied to the back of the tile. 7. ________ 8. ________

7. When a butter board is used, the guide strips should be __9__ inch(es) higher than the thickest __10__. 9. ________ 10. ________

8. One method of installing ceramic veneer calls for inserting __11__ __12__ in the horizontal joints between tiles. 11. ________ 12. ________

9. Wood wedges can be made by splitting them from a __13__ -inch wood block. 13. ________

10. Tiles can be tapped with a(n) __14__ __15__. 14. ________ 15. ________

UNIT E — SPECIALIZED JOBS

TOPIC 6 — MARBLE TILE

This topic is planned to provide answers to the following questions:

- **What precautions are required when marble tile is being set?**
- **What bonding materials are used with marble tile?**
- **How is marble tile installed?**

The increased use of tile-sized units of marble makes it mandatory for apprentice tilesetters to learn the correct methods of bonding marble. Today's tilesetters will have to work with both the polished and split-faced marble tiles.

Marble tiles are difficult to bond, and special precautions must be taken when they are being installed. Polished marble has a coating of dust. Unless steps are taken to compensate for the dust, most bonding materials will fail.

Bonding Techniques

Laboratory tests have been conducted to determine the best methods of achieving a successful bond. The preferred method is as follows:

1. Mix the marble dust and pure coat together with a trowel. Do not use a brush to apply the pure coat, because this will cause a loss of bond.
2. Use the trowel to press the pure coat onto the back of the tile. This method is illustrated in Fig. E-24.

Fig. E-24. Using the trowel to mix the marble dust and pure coat

This marble dust can be washed off before the pure coat is troweled onto the back of the tile. The tilesetter should never attempt to apply dust-covered marble tile directly against the bonding coat that has been troweled onto the surface to be tiled. This procedure would result in an inadequate bond.

A 100 percent coverage of pure coat and mortar is required between the marble tile and the surface to be covered. The grooves left by the trowel teeth must be filled in. If the grooves are left open, the contact area can be as low as 30 to 50 percent, and the bond strength will be inadequate. Moisture accumulates in the voids and causes leaching and other problems.

If the surface to be covered is concrete, it must be heavily sandblasted or bushhammered. On jobs where the marble tiles are being set in place, expansion or control joints must be provided every 16 to 20 feet (5 to 6 metres) in each direction.

Bonding Materials

The results of laboratory tests have indicated that the bond of marble tile can be improved by the use of certain materials. The highest bond strength was achieved with latex portland cement mortar. The next highest bond strength was achieved with thin-set portland cement mortar. Pure portland cement used on a conventional mortar bed also resulted in a high bond strength.

Test results showed that organic adhesives should not be used to install tile on exterior surfaces. Before using any setting mortar, the tilesetter should check the list of materials tested by the Ceramic Tile Institute.

Special Safety Precaution

Marble tiles are heavy, and care must be taken in handling them. Adequate support and scaffolding must be provided to hold these heavy materials. Serious injury and extensive property damage can be caused by incorrect handling of marble tiles.

UNIT E — SPECIALIZED JOBS

TOPIC 6 — MARBLE TILE

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The dust on the back of polished marble tile is detrimental to a good __1__.

1. ________

2. The marble dust and __2__ __3__ should be mixed together with a(n) __4__.

2. ________
3. ________
4. ________

3. The highest bond strength is achieved with __5__ __6__ cement mortar.

5. ________
6. ________

4. Organic adhesives should never be used to install marble tile on __7__ __8__.

7. ________
8. ________

5. The grooves left by the __9__ __10__ must be filled in.

9. ________
10. ________

TOPIC 7 — DRAINBOARDS AND PULLMANS

This topic is planned to provide answers to the following questions:

- **How are tiled drainboards installed?**
- **How are tiled pullmans installed?**
- **What is a V-cap, and how is it used?**

Tiled drainboards and pullmans are two of the most often requested items in the tilesetting trade. Every tilesetter must know the basics of laying out a drainboard or pullman top. A tilesetter who can produce a good layout is always in demand.

The focal point of the drainboard and pullman is the sink or basin; therefore, the tile or tile cuts must balance on either side of it, and the walls and decks must be straight and flat.

Drainboards

The tilesetter must be able to install every type of drainboard.

The straight run drainboard can be laid out with either a straight deck or a diagonal deck (Fig. E-25).

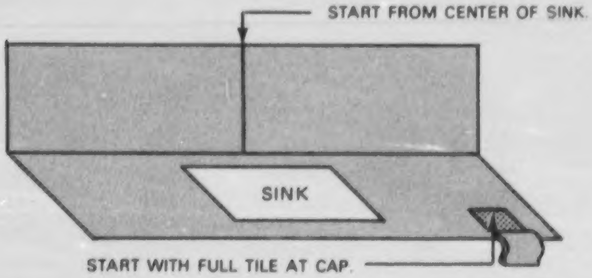


Fig. E-25. Layout of straight drainboard

On a straight deck the layout should start with a full tile at the cap. If the cuts are small at the sides of the sink, the layout should be moved a half tile.

On a diagonal deck the tilesetter should start with full diagonals at the cap and at the sink. The cut tiles should be placed at the back and sides.

An L-shaped drainboard with a straight deck and back is illustrated in Fig. E-26. The tiles at the sides of the sink may be made equal in size by starting from the centerline of the sink. If the cut at A is small, the layout should be moved a half tile. The size of cuts at C and D is determined by the layout at L. If the cap is to be aligned, it also is controlled by the layout at L. If the L-shaped drainboard is to have a diagonal deck, the tilesetter has three basic choices (Fig. E-27). They are the following:

1. Start at A on each side of the sink with full diagonals next to the cap and sink, and cut in the decks.
2. Start at corner B, and work toward sink and return. The diagonal cuts at each side of the sink should be equal.
3. Start at back corner C with full diagonals, and work toward return and sink. With this layout the tilesetter can avoid cutting to the two long walls. The diagonal cuts at each side of the sink should be equal.

The layout for a U-shaped drainboard is basically the same as that for an L-shaped unit. The tile layout should start at the sink as in Fig. E-28.

The tilesetter generally begins with a full tile at the cap and lays the tiles toward the back. To avoid a small cut at the back, the tilesetter can center the entire layout. Small cuts should be avoided whenever possible. Balance is the key to a successful layout.

On a straight joint deck, cuts can be made equal at each side of the sink by starting from the center line of the sink. If the cut at A is small, the layout should be moved a half tile. The size of the cuts at B and C is controlled by the layout at A.

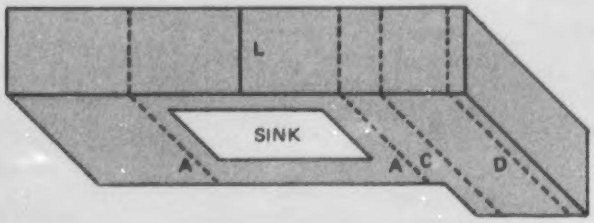


Fig. E-26. Layout of L-shaped drainboard

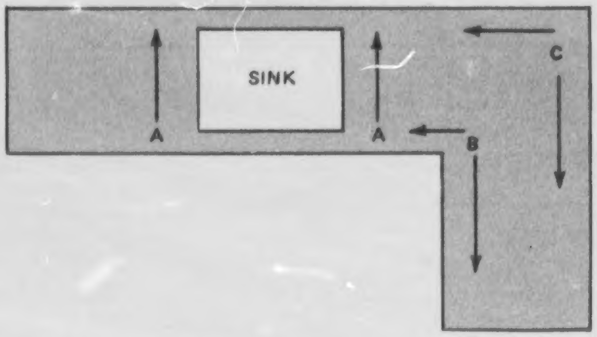


Fig. E-27. Layout of L-shaped drainboard with diagonal decks

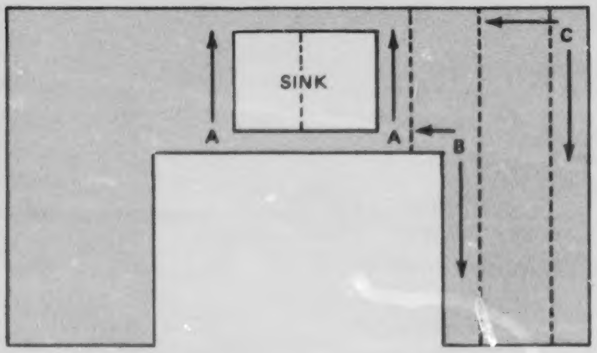


Fig. E-28. Layout of U-shaped drainboard

The layout for a diagonal deck on a U-shaped drainboard is the same as that on an L-shaped unit (Fig. E-27).

Supporting the V-Cap with Metal Strip

The Ceramic Tile Institute has developed and tested the punched metal strip as a support for the V-cap (Fig. E-29).

The strip has two rails that extend away from the front of the cabinet. The rails can be used to float the mortar for the V-cap apron. The strip has holes punched through it so that the mortar for the V-cap can be keyed into the counter mortar.

Before the metal strip is installed, the front of the cabinet should be covered with protective paper. The paper should be flush to the wood top. When the waterproof paper is placed over the counter, it should be brought down over the protective paper to the full depth that the apron of the V-cap is to cover. This acts as a cushion for the V-cap apron.

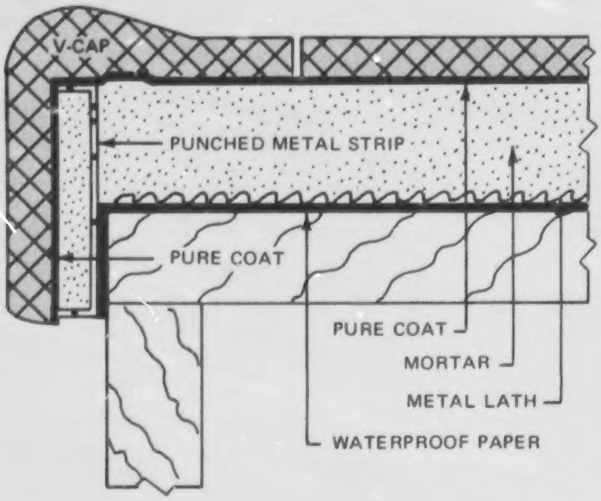


Fig. E-29. Placement of punched metal strip in a V-cap installation

The metal strip should not be cut at the corners. Joints should be at least 12 inches (30.5 centimetres) from the corners. Full pieces should be used across openings for stoves and sinks, and joints should be kept 12 inches (30.5 centimetres) from the openings.

Providing Support for the Tile

A quality tile job is not possible if the foundation is not sound. The foundation and floor joists must provide firm support (Fig. E-30). Any settling of the foundation will cause cracks in the tilework.

The cabinets should be fastened firmly to the floor. Adequate blocking is required under the subfloor at the cabinet partitions (Fig. E-31). This blocking will help prevent cracking that is caused by settling or other stresses.

The cabinet installers should check the levelness of the floor. They may have to scribe the cabinet to make it level for the tilesetters. This is especially important when the tile specifications require a dead level sinktop. If a sloping sinktop is specified, considerable dis-

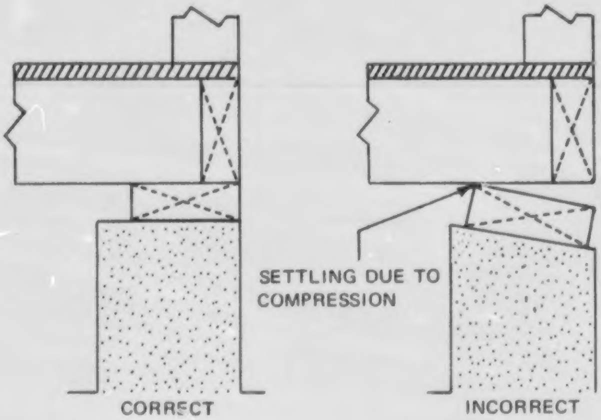


Fig. E-30. Correct and incorrect foundations

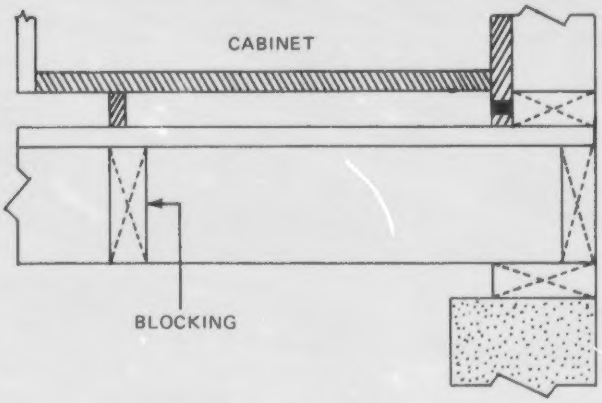


Fig. E-31. Correct blocking of subfloor to support cabinet tortion will be necessary to compensate for a cabinet that is out of level in the length.

The front top rail of the cabinet should be one continuous piece to give adequate support for the tile (Fig. E-32).

When the carpenters construct the wall that will be in back of the cabinet, they should install a piece of ¾-inch (1.9-centimetre) plywood to act as a backing for proper nailing support (Fig. E-33).

Rails and cabinet sides should be in front of the rough top to permit easier adjustment of the tile mold when it is used (Fig. E-34).

The back of the sink opening should have a positive support, such as a 1 by 4 inch (2.5 by 10.2 centimetre) cleat, correctly nailed against the plaster wall. When a tile cove is to be used at the splash, additional support is needed. A piece of 2 by 4 inch (5.1 by 10.2 centimetre) board should be nailed over the 1 by 4 inch (2.5 by 10.2 centimetre) cleat (Fig. E-35).

When a heavy load of water and dishes is in the sink, considerable flexing will occur if the sink is not correctly supported. In addition, if the sink is heated to 140° F. (60° C), it will expand 0.007 inch (0.01 centimetre) in width and 0.008 inch (0.02 centimetre) in length.

Because sinks are made in various widths, the cabinet should be approximately 4 inches (10 centimetres) wider than the sink from front to back of the flange when tile cove is specified and 2 inches (5 centimetres) wider when a 90-degree corner is to be used (Fig. E-36).

The cabinet top should be made of 1 by 6 inch (2.5 by 15.2 centimetre) sheathing boards spaced ¼ inch (0.6 centimetre) apart (Fig. E-37). When this spacing is provided, the boards will not warp and crack the tile.

Plywood should not be used under tile, because the plywood will become warped and will crack the tile (Fig. E-38). Where plywood must be used, random cuts with a portable hand saw should be made through the plywood (Fig. E-39). These cuts will permit both sides of the plywood to remain relatively equal in moisture content.

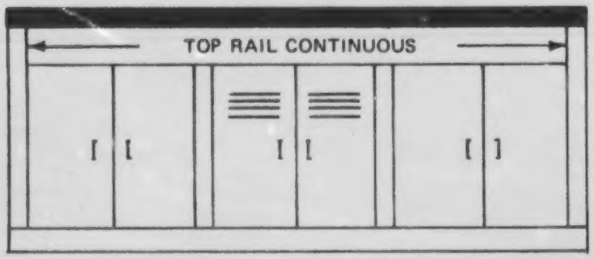


Fig. E-32. Supporting tile with continuous top rail

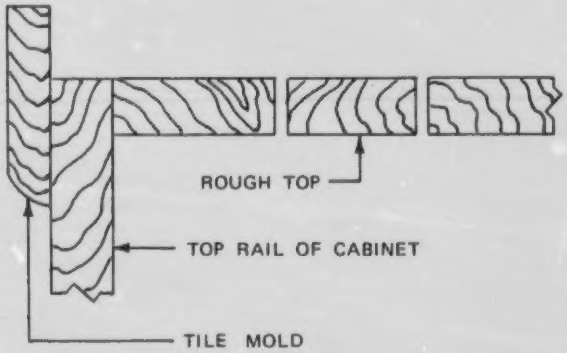


Fig. E-34. Correct placement of top rail

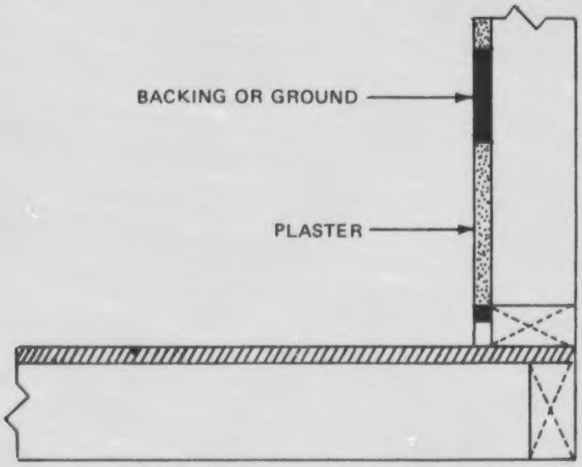


Fig. E-33. Placement of backing for support

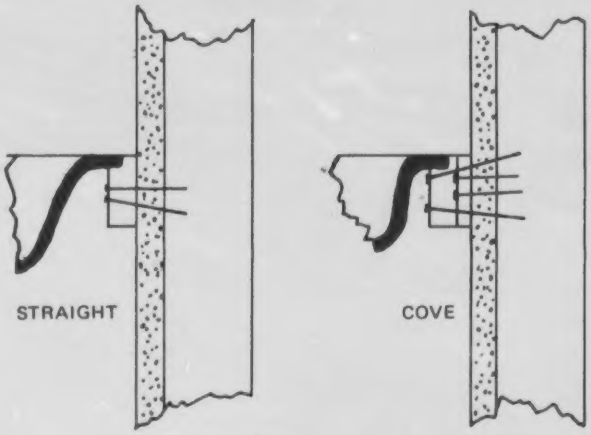


Fig. E-35. Installation of support for sink

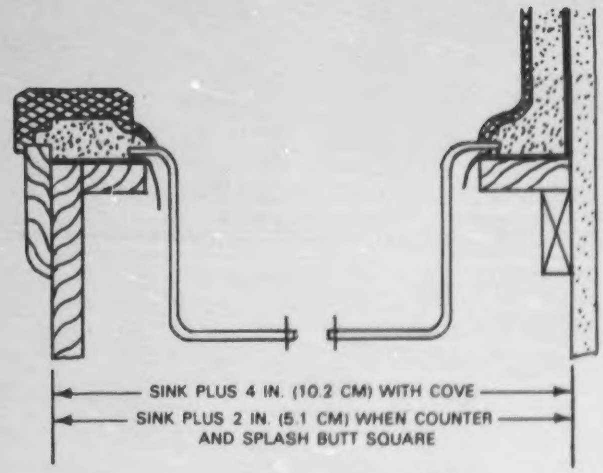

SINK PLUS 4 IN. (10.2 CM) WITH COVE
SINK PLUS 2 IN. (5.1 CM) WHEN COUNTER AND SPLASH BUTT SQUARE

Fig. E-36. Installation of sink

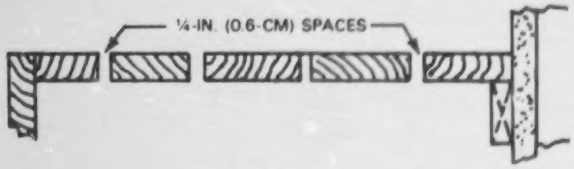


Fig. E-37. Spacing of sheathing boards

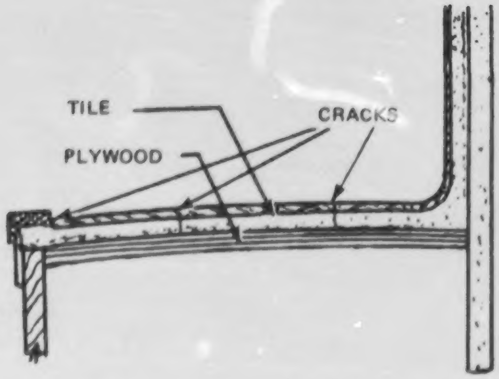


Fig. E-38. Installation showing warped plywood

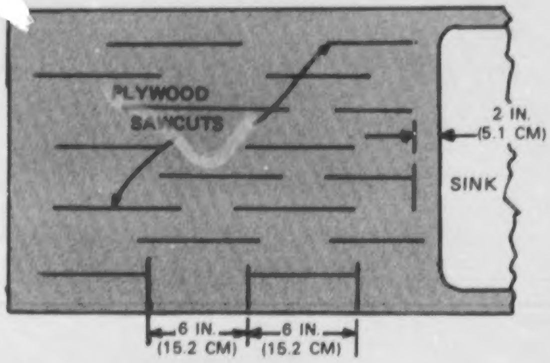


Fig. E-39. Sawcuts made in plywood to prevent warping

Applying Felt and Lath

The cabinet deck should be checked for correct nailing and spacing. Then the tilesetter should lay 15-pound (7-kilogram) felt over the rough top, folding it tightly into the corners (Fig. E-40). If the felt is rounded in the corners, it will break when the lath is installed (Fig. E-41).

The felt should be lapped into the sink cabinet cavity so that the mortar will not contact the wood (Fig. E-42). This will permit the sink flanges to be embedded into the mortar equally around the perimeter of the sink. The mortar will cure correctly because the moisture will not be withdrawn. The boards will not expand and contract abnormally. In the event water does get into the installation, dry rot will be prevented.

The deck lath should be held away from the wall 1 inch (2.5 centimetres) for a 90-degree corner and 3 inches (7.6 centimetres) when tile cove is used. Any cracks will occur at a joint and can be pointed up easily. If the lath is continuous, any motion in the sink cabinet may cause the backsplash to pull away from the wall or cause the lower splash tiles or cove to crack.

Using a Pencil Rod

To prevent cracks in the tile at the front corners of the sink or other opening, the tilesetter should place a piece of pencil rod in the center of the mortar (Fig. E-43). Some cabinetmakers, in order to save expenses, will lay materials crosswise to cover the top. This makes the use of a pencil rod even more imperative.

Installing a V-Cap

Before the V-cap is installed, the front of the cabinet should be protected with waterproof paper. When waterproof paper is being applied to the counter top, the paper should be brought down to the full depth of the apron that the V-cap is to cover (Fig. E-44). The metal lath or wire also is brought down to the depth of the apron.

The V-cap should be held at least ⅛ inch (0.3 centimetre) from the cabinet.

A light, even layer of pure coat should be applied to the V-cap to cause it to adhere to the mortar bed. The V-cap is fully backed with mortar.

The bottom edge of the V-cap should be set 34⅝ inches (88 centimetres) above the finish floor material to allow for the dishwasher.

The apron on the V-cap should be large enough to cover the edge of the rough deck top and extend up to form at least a ¾-inch-thick (1.9-centimetres-thick) bed of mortar. The mortar bed should never exceed 1 inch (2.5 centimetres) in thickness.

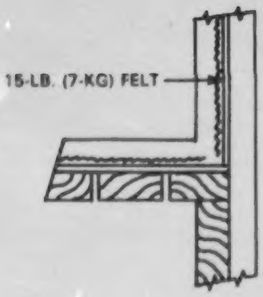


Fig. E-40. Correct placement of felt

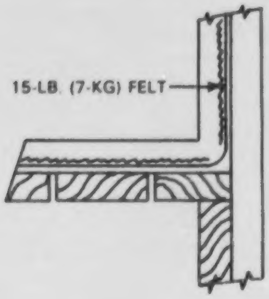


Fig. E-41. Incorrect placement of felt

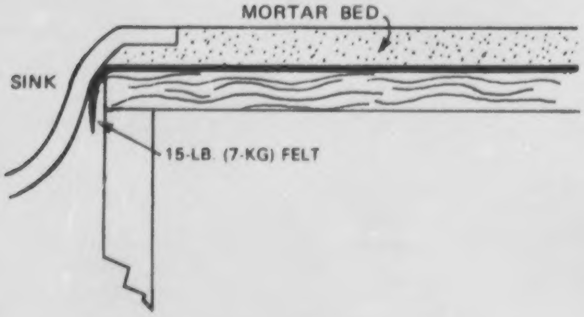


Fig. E-42. Installation showing felt lapped into sink cavity

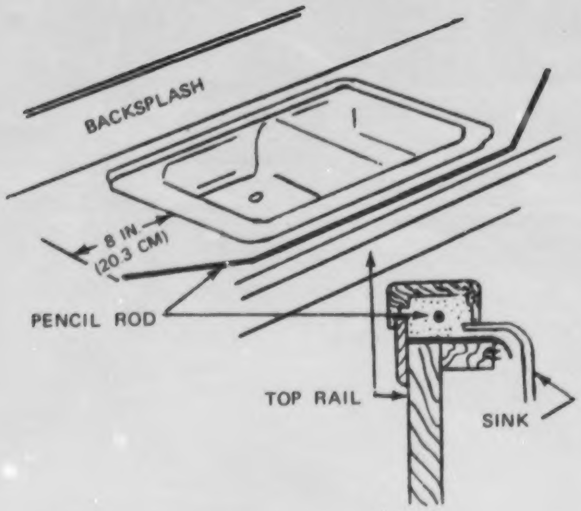


Fig. E-43. Placement of steel pencil rod to prevent cracking

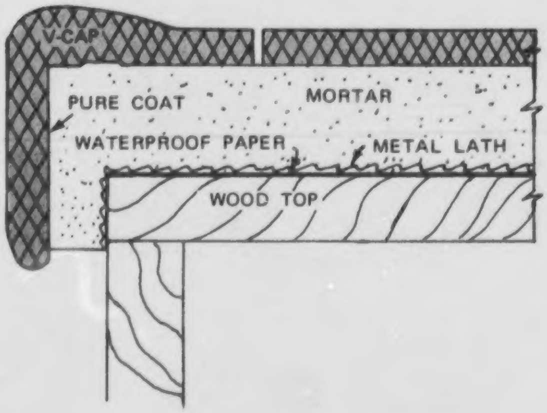


Fig. E-44. Installation of V-cap

Reinforcing Large Areas

The use of built-in units has resulted in large areas of tile on kitchen cabinets. These areas often measure 3 feet 6 inches (1.1 metres) in width by 7 to 8 feet (2.1 to 2.4 metres) in length.

In addition to the metal lath or wire mesh that is used in drainboard construction, pieces of pencil rod should be bent into S shapes and placed in the center of the mortar bed (Fig. E-45). This will prevent the cracking that often occurs in large installations that are not reinforced.

Setting a Stainless-Steel Sink

Before a stainless-steel sink is set in place, the rough tile opening upon which the flange is clamped must be straight and level. If the opening is not level, the sink will not form a true fit when it is embedded in the mastic and clamped (Fig. E-46).

Reinforcing the Corners

When a "butterfly" sink corner is used, a galvanized No. 16 wire or 8d nail reinforcement should be placed in the mortar to prevent cracking (Fig. E-47).

Preventing Seepage

To prevent moisture from seeping into the sink flange, the tilesetter should apply caulking as shown in Fig. E-48. The sink flange must be thoroughly dry before the caulking compound is applied, or it will not adhere.

Setting the Backsplash

The backsplash should be floated straight and plumb. It should be floated independently of the deck

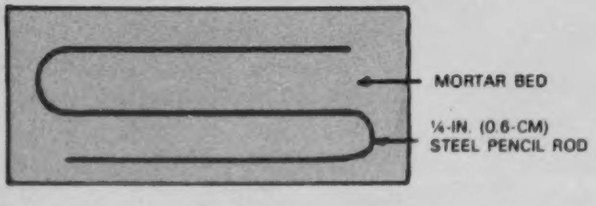

MORTAR BED
¼-IN. (0.6-CM) STEEL PENCIL ROD

Fig. E-45. Placement of steel pencil rod in the mortar bed

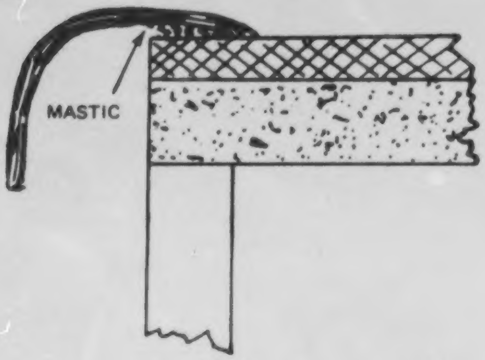


Fig. E-46. Installation of stainless-steel sink

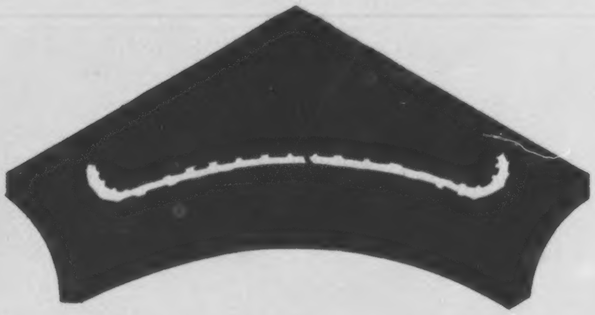


Fig. E-47. Wire reinforcement at corner tile

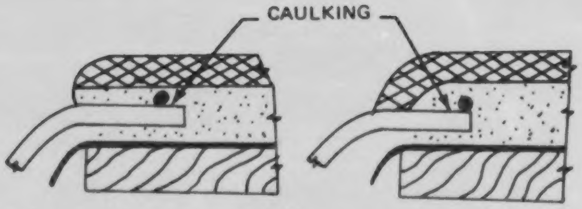


Fig. E-48. Placement of caulking

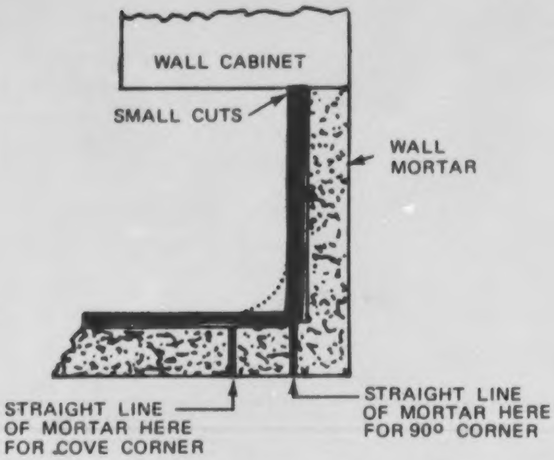

WALL CABINET
SMALL CUTS
WALL MORTAR
STRAIGHT LINE OF MORTAR HERE FOR COVE CORNER
STRAIGHT LINE OF MORTAR HERE FOR 90° CORNER

Fig. E-49. Installation of backsplash

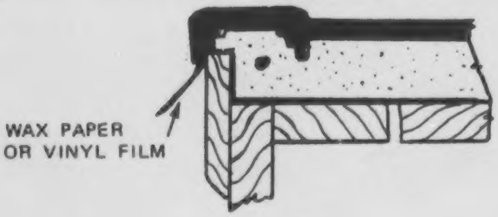

WAX PAPER OR VINYL FILM

Fig. E-50. Installation showing tile mold protected from moisture

to prevent binding of the deck to the splash. The tile should be laid from the center of the drainboard to the outside. The layout should be planned so that any small cuts can be made in the least conspicuous places (Fig. E-49).

Waterproofing the Tile Mold

Vinyl plastic film or waterproof paper should be lapped over the tile mold to prevent moisture from being withdrawn from the mortar into the wood (Fig. E-50). The moisture would discolor the wood and cause it to swell and break away from the cap.

Using a Surface Bullnose

A surface bullnose type of installation (Fig. E-51) may prevent the damage that is sometimes caused by vibration from dishwashers or waste disposals.

Setting a Window Return

To prevent the cracking of tile at a window return, the tilesetter should complete the installation as shown in Fig. E-52.

Mixing the Mortar

The mortar for a backsplash should consist of one part portland cement, six parts washed plaster sand, and one part hydrated lime. Deck mortar should be made up of one part portland cement and five parts washed plaster sand. If the mortar is too rich in cement, shrinkage will be excessive and the tile will crack.

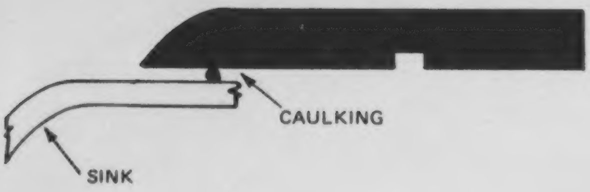


Fig. E-51. Surface bullnose installation

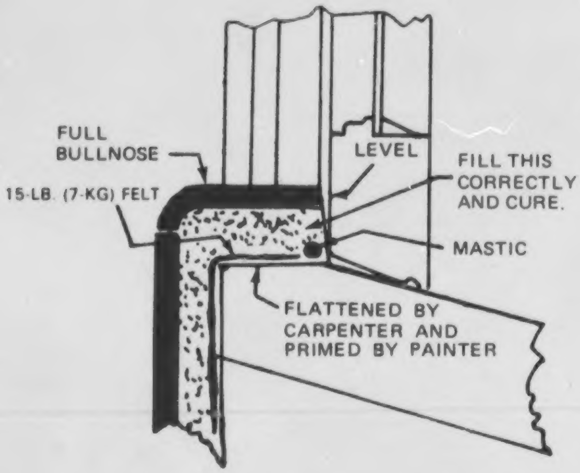

FULL BULLNOSE
15-LB. (7-KG) FELT
LEVEL
FILL THIS CORRECTLY AND CURE.
MASTIC
FLATTENED BY CARPENTER AND PRIMED BY PAINTER

Fig. E-52. Installation showing a window return

Curing the Grout

Portland cement grouts should be cured by covering the tilework with clean waterproof paper for 24 hours. This also protects the finished work from damage by other trades.

Installing a 90-Degree Corner

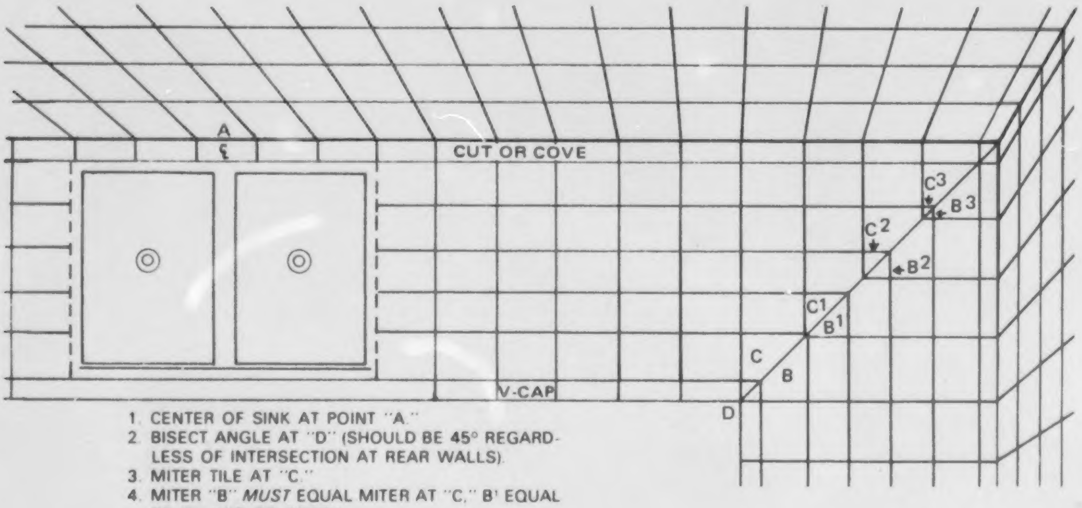
A 90-degree corner should be installed as shown in Fig. E-53. The tilesetter should start at the center of the sink and make equal cuts at each side of the sink. The bisected angle at D must be a true 45-degree angle. The mitered tile at C should be on a line with the bisected angle. Miter B must equal miter C. The alignment for the adjoining splash is established at this time. Miters must be smooth and equal in length.

Pullman Cabinets

The installation of a tile deck with a square or rectangular basin was illustrated in Fig. E-25. In the installation of a tile deck with a round or elliptical basin, the major problem is the cutting of the tiles around the basin in a smooth and circular pattern. The problem is compounded if ceramic mosaic or glass is used.

Two methods have been developed for cutting tile for a round basin. They are the following:

1. Set a compass for the size of trim to be used, and let it ride on the edge of the basin while scribing a line on the tile or mud. The line is scribed back from the edge of the basin. The tile is cut to this line (Fig. E-54).
2. Cut a template out of cardboard (or similar material), using the basin as a guide. The template should be the size of the basin less the size of the trim to be used around the basin. This template is placed over the basin, and a line is drawn on the tile or mud. There should be at least a ⅛-inch (0.3 centimetre) reveal between the trim and the edge of the basin. If the tile deck is to be flush with the basin, the tile cuts must be honed smooth. A $\frac{1}{16}$-inch (0.2-centimetre) joint between the tile and the basin is desirable.



1. CENTER OF SINK AT POINT "A."
2. BISECT ANGLE AT "D" (SHOULD BE 45° REGARDLESS OF INTERSECTION AT REAR WALLS).
3. MITER TILE AT "C."
4. MITER "B" *MUST* EQUAL MITER AT "C," B^1 EQUAL TO C^1, AND SO FORTH.

Fig. E-53. Layout of a 90-degree corner

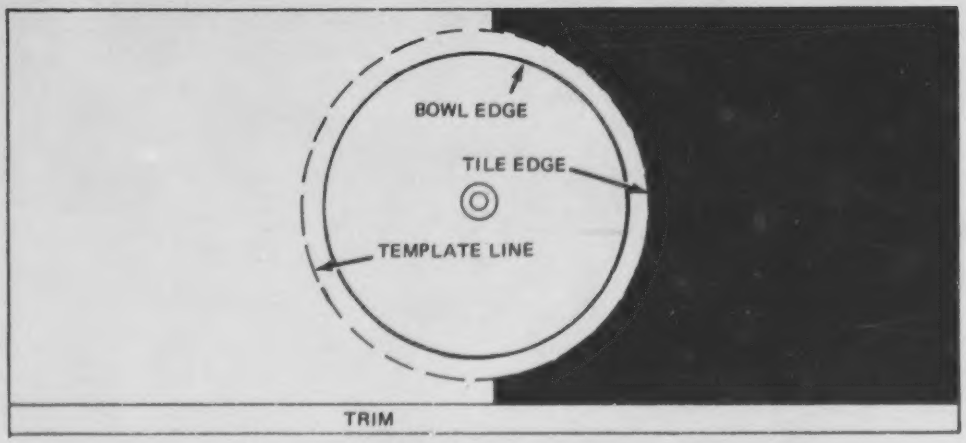

BOWL EDGE
TILE EDGE
TEMPLATE LINE
TRIM

Fig. E-54. Installation of tile deck with round basin

UNIT E — SPECIALIZED JOBS

TOPIC 7 — DRAINBOARDS AND PULLMANS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. On a straight drainboard, the layout should start with a(n) 1 2 at the cap.
1. ________
2. ________

2. Three types of drainboards are the 3, 4, and 5.
3. ________
4. ________
5. ________

3. The bottom of the V-cap should be set 6 inch(es) above the finish floor material.
6. ________

4. The punched metal strip has two 7 that extend away from the front of the 8.
7. ________
8. ________

5. The V-cap must be backed with 9.
9. ________

6. A common practice is to start at the front of the 10 and lay toward the back.
10. ________

7. Metal strip should not be cut near a(n) 11 or a(n) 12.
11. ________
12. ________

8. A sink installation can be strengthened by the use of a(n) 13 14 embedded in the mortar.
13. ________
14. ________

9. The wood material that is not recommended for the rough top of a drainboard deck is 15.
15. ________

10. Before the V-cap is installed, the front of the cabinet should be 16.
16. ________

11. The mortar bed for a drainboard should not exceed 17 inch(es) in thickness.
17. ________

12. The backsplash should be 18 independently of the deck.
18. ________

13. The mortar for a backsplash should consist of 19 part(s) portland cement, 20 part(s) sand, and 21 part(s) hydrated lime.
19. ________
20. ________
21. ________

14. Deck mortar should be made up of 22 part(s) common cement and 23 part(s) sand.
22. ________
23. ________

15. The two methods of cutting in an oval or round basin are called 24 and 25.
24. ________
25. ________

UNIT E — SPECIALIZED JOBS

TOPIC 8 — FLAT ARCHES

This topic is planned to provide answers to the following questions:

- **What tools are needed in laying out an arch?**
- **What terms are used in describing an arch?**

The natural beauty and distinctive appearance of tiled arches add drama and warmth to any interior. A correctly tiled arch is a tribute to the skill of the tilesetter. Scientifically, an arch is a means of spanning an opening by transforming downward pressure into horizontal or diagonal thrust. However, because the work installed by the tilesetter does not bear the load, the problems of strength in arches will not be discussed here.

Application of the principles discussed in this and the succeeding topic should enable the apprentice tilesetter to install arches that will accentuate any decor. The tilesetter may be called upon to lay out elliptical or other curved shapes for fountains, swimming pools, and garden pools. The same method used to lay out an arch or other feature on an elevation drawing is equally effective in laying out a similar shape on a plan drawing.

The tools and equipment used for the layout of an arch are the following: a large piece of flat paper, wallboard, or plywood on which to draw; a compass; dividers or a trammel; a steel square; straightedges and a rule; string; and a pencil (Fig. E-55).

The tilesetter does not need to be concerned with the actual construction of an arch, because it is already in place when he or she begins work. However, to be sure other workers have done their work correctly and to determine the exact cuts for the tiles to be used, the tilesetter should make a complete layout for each arch.

Fig. E-55. Using a trammel to lay out an arch

Terminology

The apprentice tilesetter should first become familiar with the terms used to describe the various parts of an arch. The terms in the following list are illustrated in Fig. E-56.

Abutment—The part of the pier or wall that receives the thrust of the arch

Crown—The highest point of an arch

Extrados—The exterior curve of an arch, sometimes called the back

Haunch—Either of the sides of an arch between the crown and skewback

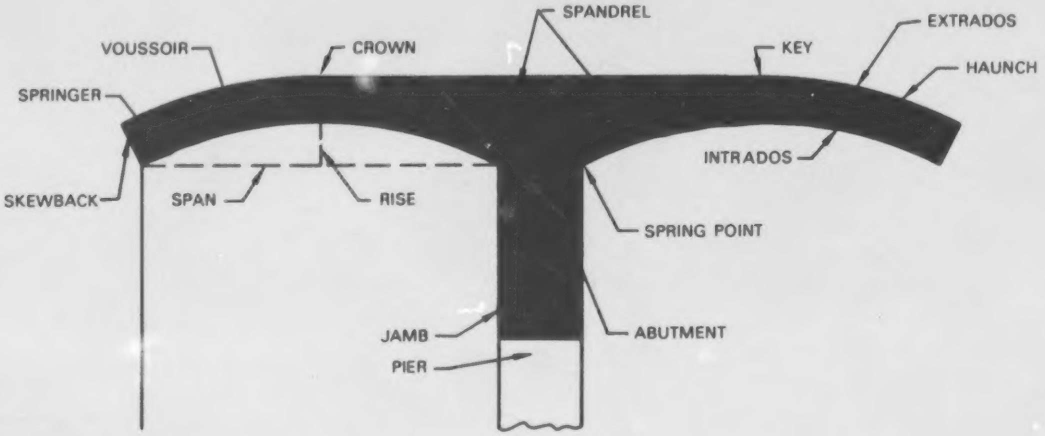


Fig. E-56. Arch terminology

Intrados (or soffit)—The interior curve of an arch

Jamb—An upright piece forming the side of an *opening; hence, the* sides of the piers or abutments

Key—The uppermost or central voussoir of the arch

Pier—A pillar or post supporting an arch; the wall between two openings

Rise—The vertical distance between the highest point of the intrados and the spring points

Skewback—The upper surface of the abutment, against which the voussoirs abut

Span—The width of the opening of an arch

Spandrel—The space between the extrados of an arch and a right angle formed by a line extended from the pier to meet the level of the crown; or, the space between the extradoses of two contiguous arches and a horizontal line connecting their crowns

Springer—The end or lowest voussoir of an arch

Spring points—The points from which the under curves of the arch begin

Voussoirs—The tiles or stones that make up an arch

Flat (Jack) Arch

A flat-shaped opening usually is treated in a conventional manner, with tiles laid straight across the top. But occasionally, to carry out a decorative effect, the top of the opening is done in the style of an arch. When the arch style is used for this opening, the following layout procedures are recommended for use by the tilesetter. The procedures are illustrated in Figs. E-57 and E-58.

1. Use AB as a radius and A as a center point, and strike an arc at F.
2. Use AB as a radius and B as a center point, and strike an intersecting arc at F.

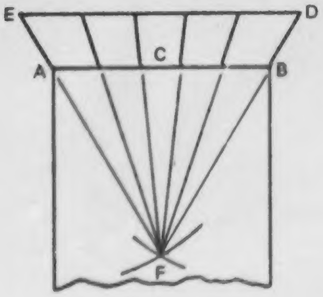


Fig. E-57. Layout of a flat arch

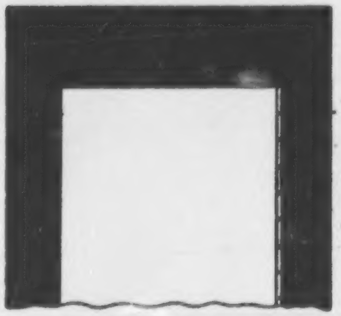


Fig. E-58. Completed flat arch

3. Draw lines FA and FB, extending them to indefinite lengths beyond A and B.
4. Draw line ED parallel to line AB at the correct distance for the size tile to be used, intersecting the extended lines FA at E and FB at D.
5. Divide line ED into equal spaces in accordance with the size of the tile and, from these division points, draw lines to point F, giving the angle of the cut of the voussoirs. Note that the ends of the voussoirs are horizontal and *not* at right angles to the radius of the arch.

UNIT E — SPECIALIZED JOBS

TOPIC 8 — FLAT ARCHES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The highest point of an arch is the 1 .
1. ________

2. The width of an arch is called the 2 .
2. ________

3. Arches are designed to transform the downward pressure over an opening into 3 or 4 thrust.
3. ________
4. ________

4. The space between the level of the crown and the extrados of the arch is called the 5 .
5. ________

5. The springer is the 6 voussoir of the arch.
6. ________

6. The upper surface of an abutment, against which the voussoirs abut, is called the 7 .
7. ________

7. The rise is the 8 distance between the highest point of the intrados and the level of the 9 points.
8. ________
9. ________

8. The side surface of the part of the structure extending from the arch to the pier is called the 10 .
10. ________

9. The pier is the 11 between 12 13 .
11. ________
12. ________
13. ________

10. The interior curve of an arch is called the 14 or 15 .
14. ________
15. ________

UNIT E — SPECIALIZED JOBS

TOPIC 9 — CURVED ARCHES

This topic is planned to provide answers to the following questions:

- **What layout procedures are recommended for curved arches?**
- **How is tile set on a curved arch?**

The curved arches that the tilesetter will have to master include segmental, semicircular, elliptical, three-centered, and Gothic arches.

Laying Out Arches

Layout procedures for the different arches have been developed in the trade. (An alternative method of determining the radius point of an arch is described at the end of this topic.)

Segmental Arch

The curve of a segmental arch has a constant radius, but the arch is less than half a circle. The amount of rise of a segmental arch depends on the architectural design, but a good rule is to make the rise equal to one-eighth the span. The recommended layout procedure is as follows:

1. Start with line AB representing the span of the arch and O as its exact center. Place point C directly above O at a point approximately one-eighth the length of AB.
2. Extend line CO down an indefinite distance (Fig. E-59).
3. Draw line AC.
4. Using A as a center and then C as a center and with a radius more than one-half AC, strike intersecting arcs at F and at G.
5. Extend line FG to intersect extended line CO at D. Line DOC is the radius for the arc ACB, which is the intrados of the arch.
6. Extend line DOC to J by the width of the tile to be used (Fig. E-60). The length of line DOJ is the radius of the arc HJK.
7. Divide arc HJK into equal parts approximately the size of the tile to be used. From these points, draw lines meeting at point D, giving the angle of the cut of the segments.

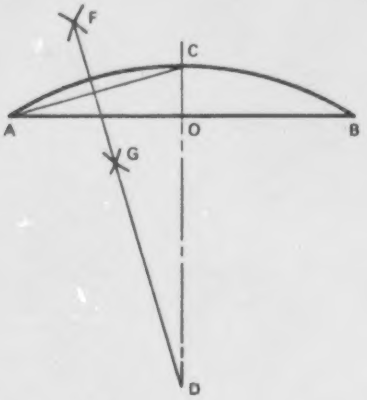


Fig. E-59. Layout of a segmental arch

Semicircular Arch

When an arch contains half of a complete circle, it is called a semicircular arch (Figs. E-61 and E-62). The layout of this arch is quite simple because the center of a line across the span is the center of the

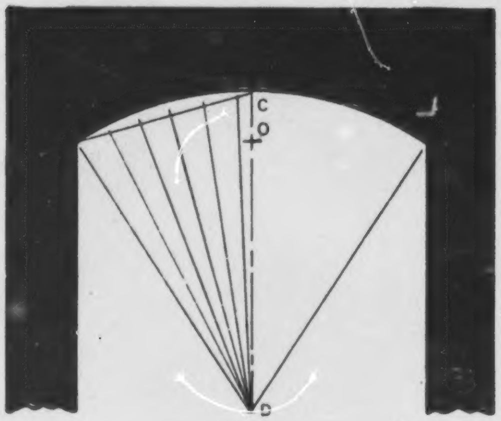


Fig. E-60. Segmental arch, showing voussoirs

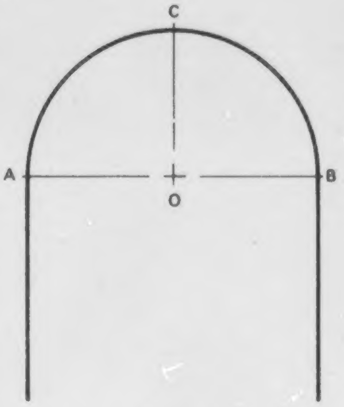


Fig. E-61. Layout of semicircular arch

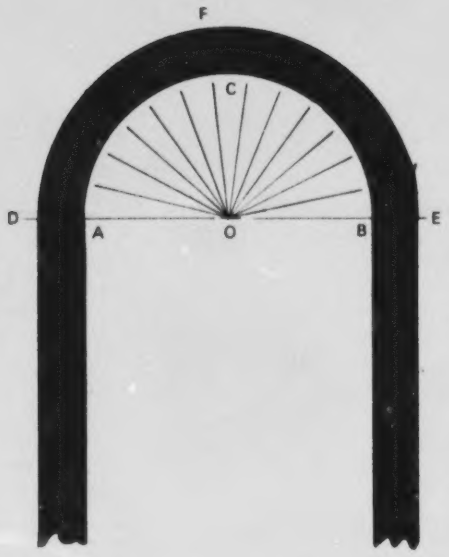


Fig. E-62. Semicircular arch, showing voussoirs

circle. The recommended layout procedure is as follows:

1. Start with line AB representing the span of the arch and O representing its midpoint.
2. With O as a center, using a radius equal to AO, or one-half the span, strike the arc ACB.
3. Extend line AB to D and E, which is the necessary distance for the tile that is to be used for the casing.
4. With O as a center, using a radius equal to DO, strike arc DFE.
5. Lay out even spaces on arc DFE.
6. From these points draw lines to the center O, giving the angle of cuts of the voussoirs.

Elliptical Arch

The elliptical arch requires the utmost accuracy in layout. The span of this arch is called the major axis of the ellipse; the rise is called the minor axis. The following procedure is recommended:

1. On line AB, which represents the span of the arch (Fig. E-63), mark distance AE equal to twice the rise (CO is the rise).
2. Divide EB into three equal parts.
3. With O as a center and a radius equal to the length of two of the parts of EB, scribe arcs cutting AB at F and G.
4. Extend line OC indefinitely.
5. With a radius equal to GF, scribe arcs from G and F intersecting line OC at H. Draw lines GH and FH and extend them.
6. With a radius equal to HC, using H as a center, scribe the arc JCK intersecting the extended lines GH and FH.

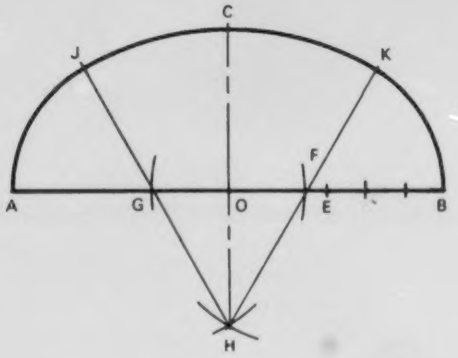


Fig. E-63. Layout of an elliptical arch

7. With a radius equal to AG, and G as a center, scribe arc AJ.
8. With a radius equal to FB, using F as center, scribe arc BK.

A simplified method of laying out an elliptical arch is illustrated in Fig. E-64. In the illustration the difference between AO and BO is OC or the radius of the circle. The following procedure is recommended:

1. Draw circle with radius OC.
2. Draw 45-degree diagonals through O, and intersect the circumference of the circle at points C, C^1, C^2, and C^3.
3. From points C, C^1, C^2, and C^3, draw 45-degree diagonals to intersect major axis AOA^1 and establish points D and D^1.
4. With a radius equal to DOD^1 and using D and D^1 as centers, establish points F and F^1.

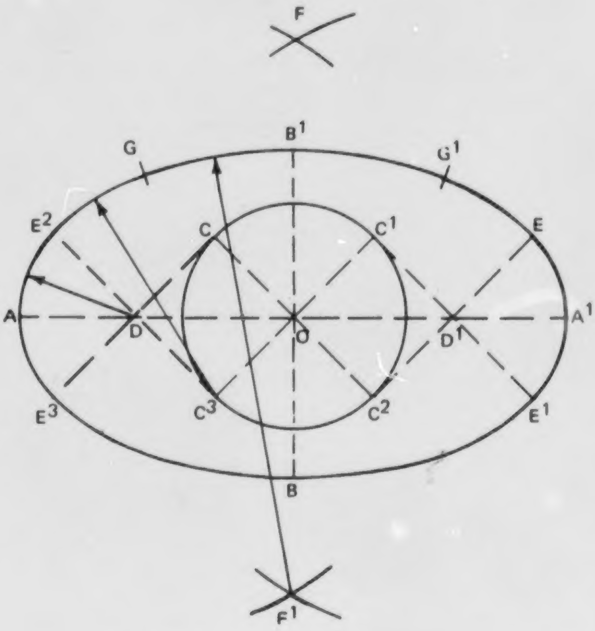


Fig. E-64. Simplified layout of an ellipse

5. Using a radius equal to DA with D as the center, draw arc E^3AE^2. Using the same radius with D^1 as the center, draw arc EA^1E^1.
6. With a radius equal to F^1B^1 and F^1 as the center, draw arc GG^1.
7. With a radius equal to C^3E^2 and C^3 as the center, draw arc E^2G. Proceed as above until full ellipse is established.

To lay out the voussoirs for an elliptical arch as shown in Fig. E-65, the beginning tilesetter should use the following procedure:

1. Extend radii GA, HJ, HC, HK, and FB for the distance necessary for the size of the tile to be used for the casing. This will give points L, M, N, P, and Q.
2. On the arcs LM, MN, NP, and PQ, lay out uniform-size voussoirs. The voussoirs with the arcs LM and PQ are cut to the centers G and F; the voussoirs within the arc MNP are cut to the center H.

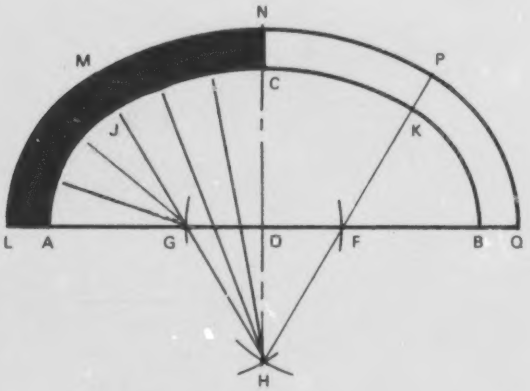


Fig. E-65. Elliptical arch, showing voussoirs

Some tilesetters prefer another method of laying out an ellipse. When the tilesetter has worked with enough shapes of this sort to be able to estimate approximately where the tangent point of the major and minor arcs will be, the following method is quicker and easier than the preceding one:

1. Establish point D as near as possible to the tangent point for the major and minor arcs (Fig. E-66).
2. Draw lines AD and DC.
3. Bisect line DC. Extend the bisecting line until it intersects the centerline OC at G. A radius equal to GC will be the radius for the major arc.
4. Bisect the line AD. Extend the bisecting line until it intersects line AB at point E. A radius that is equal to AE will then be the radius for the minor arc of the ellipse.
5. Draw a line from G through E, intersecting ellipse ACB at F. Point F will be the true tangent point of the two arcs.

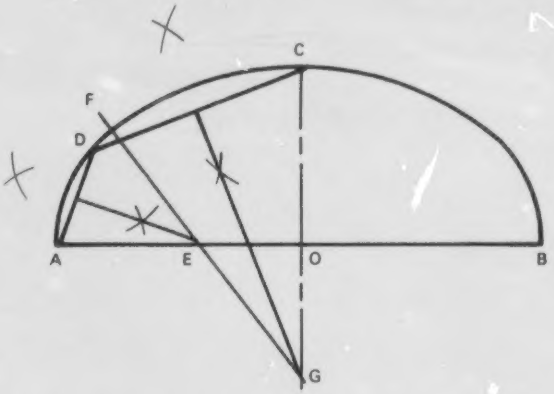


Fig. E-66. Layout of an ellipse by estimating point near tangent point for major and minor arcs

An ellipse that is to be covered with plaster may be laid out very simply with a pin and a piece of string (Fig. E-67). The recommended procedure is as follows:

1. With C as the center and a radius equal to one-half the span, or OA, strike arcs intersecting span AB and establishing points D and D^1.
2. Drive pins at points D, C, and D^1.
3. Tie string tightly around the three pins; then pull pin C.
4. Insert a pencil in the loop, and take up the slack. Place the pencil point on point A. Then, keeping an even tension on the string, move the pencil as shown in Fig. E-67. When it is held in this manner, the pencil will trace a true ellipse.

Because keeping an even tension around the ellipse is difficult, the tilesetter will find the best procedure is to mark one half on a template and transfer the other half.

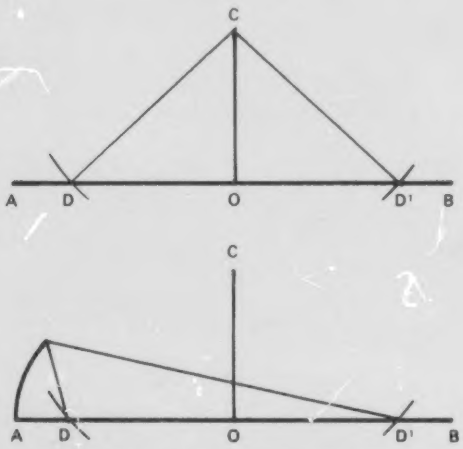


Fig. E-67. Pin and string method of laying out an ellipse

Three-Centered Arch

The three-centered arch is a form of the elliptical arch; however, the joining of the arcs is not perfectly smooth, as in a true ellipse. The layout procedure, which is illustrated in Fig. E-68, is as follows:

1. Divide the baseline AB into three equal parts, and locate points D and E.
2. Determine halfway marks between each. Use these as centers, and scribe circles with diameters meeting at D and E.
3. Extend Line OC to lowest edge of inner circle, to point F.
4. Draw lines from F to D and F to E and beyond.
5. With a radius equal to AD and D as the center, scribe arc AG, with G the point of intersection of extended line DF. With a radius equal to EB and using E as a center, describe arc BH. H is the point of intersection of extended line EF.
6. With a radius that is equal to FC and using F as a center, scribe the arc GCH, which forms the central arc.
7. Determine the direction of the joints by extending lines AB, OC, DG, and EH the distance of the size tile to be used, establishing points J, K, L, M, and N. Divide each outer arc into equal parts, and draw lines from the radial points used for scribing the three curvatures.

An alternative method, although not very accurate, may be used to determine the direction of the joints (Fig. E-69). The procedure is as follows:

1. Attach a small square at the center of a given length of wood.
2. Place this length of wood against the intrados along the chord line, which is inside the arc of the arch.
3. Using the known width of voussoirs along the extrados to square from, draw the radial lines.

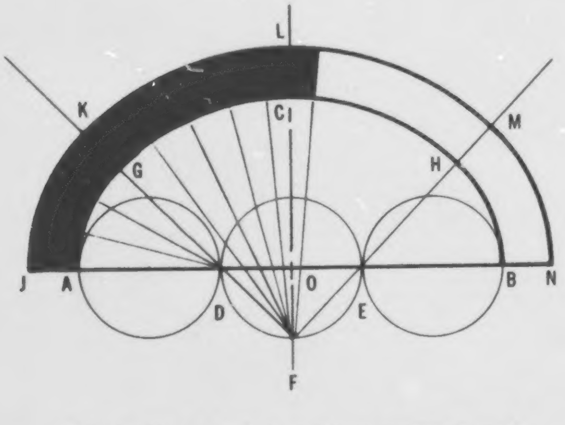


Fig. E-68. Layout of a three-centered arch

Gothic (Pointed) Arch

The Gothic arch is used most often in church architecture. Gothic arches are often set with a joint at the center, but many of them are set with a keystone. The layout procedure described here is based on the use of a center joint. The procedure, which is illustrated in Figs. E-70 and E-71, is as follows:

1. Extend line AOB, which is the span of the arch, an indefinite length (Fig. E-70).
2. Draw lines AC and BC. Point F is the exact center of AC, and G is the exact center of BC.

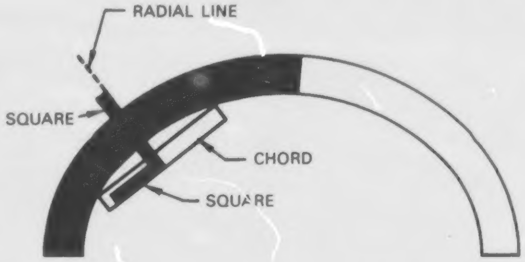


Fig. E-69. Chord and square method of laying out a three-centered arch

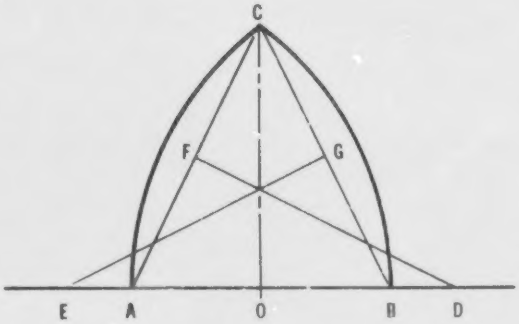


Fig. E-70. Layout of a Gothic arch

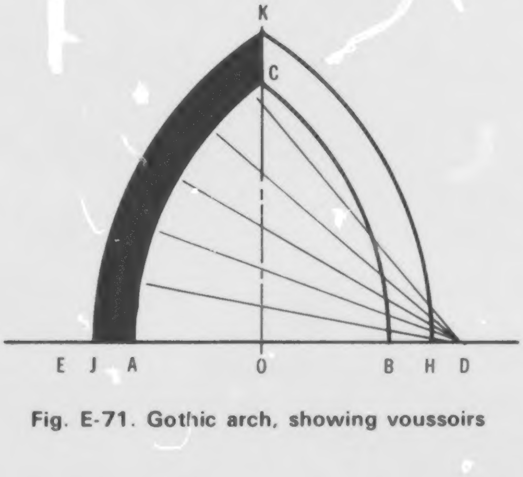


Fig. E-71. Gothic arch, showing voussoirs

3. Draw line FD perpendicular to AC, and extend it until it intersects line AB at D.
4. Draw line GE perpendicular to BC, and extend it until it intersects line AB at E.
5. With E as center and a radius equal to EB, strike the arc BC.
6. With D as center and a radius equal to DA, strike the arc AC.
7. Extend radius EB to point H, radius DA to point J, and line OC to point K by the distance necessary to take care of the casing (Fig. E-71).
8. Step off even divisions on arcs HK and JK. From these, draw lines that converge on centers E and D, giving the correct angle of cut for the voussoirs.

Setting the Tile

After the layouts have been made, the cuts determined, and the tile cut, the paper or plywood pattern that has been cut to fit the intrados may be fastened to the arch with the radial lines showing. After the setting bed has been floated, the face tiles can be placed in accordance with the lines shown on the pattern. They are then tapped into place. If the arch is semicircular, a radius board may be used as a guide.

The soffit and jamb may be floated with a template. The bullnose trim on the outer and inner curves and the jamb tiles must be placed so that the grout lines match those of the face tiles as shown in Fig. E-72.

The various steps to be followed in setting tile on curved arches are illustrated in Figs. E-73 through E-76.

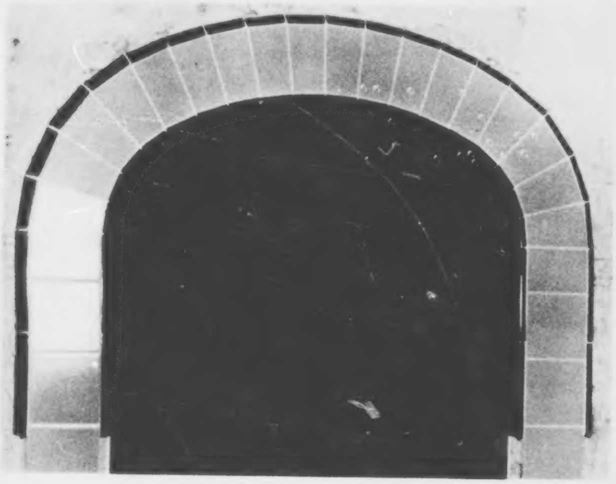


Fig. E-72. Elliptical arch, showing fit of bullnose and soffit tiles

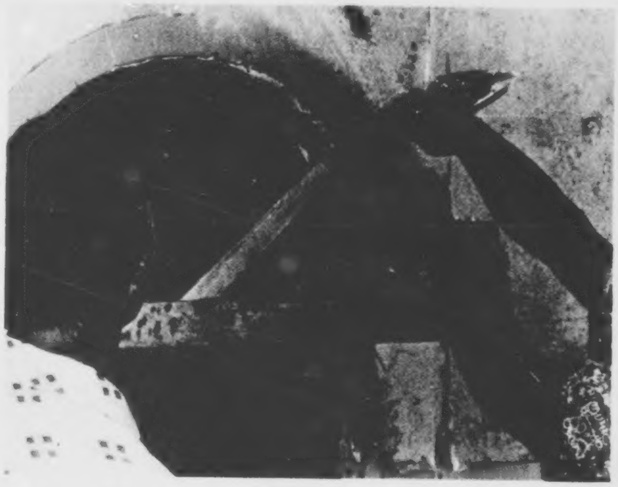


Fig. E-74. Setting tile on face of arch

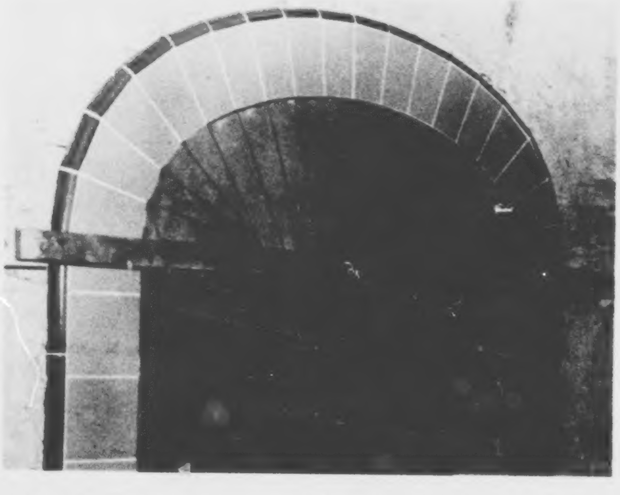


Fig. E-73. Tiles set by holding drawing to voussoirs

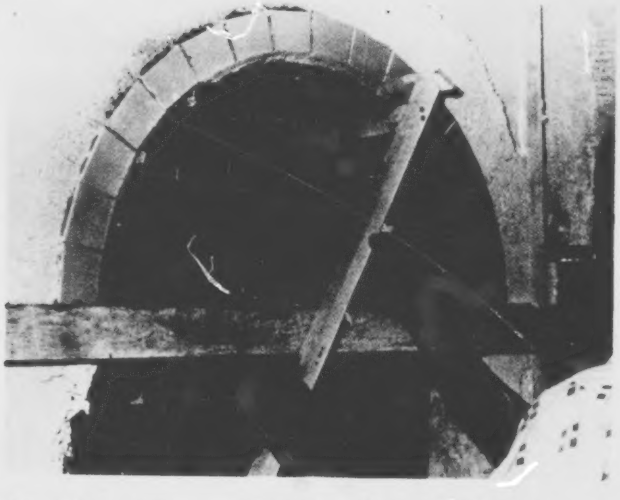


Fig. E-75. Floating mortar on intrados of semicircular arch

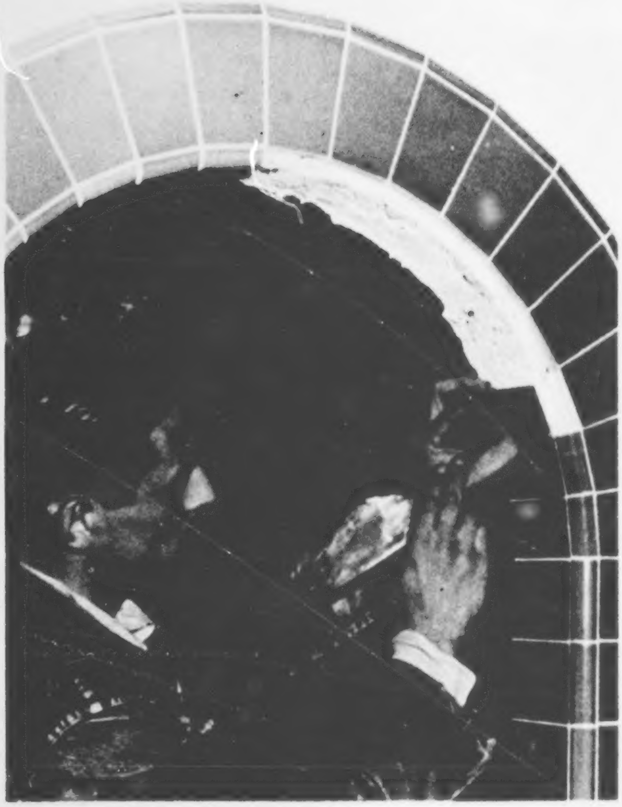


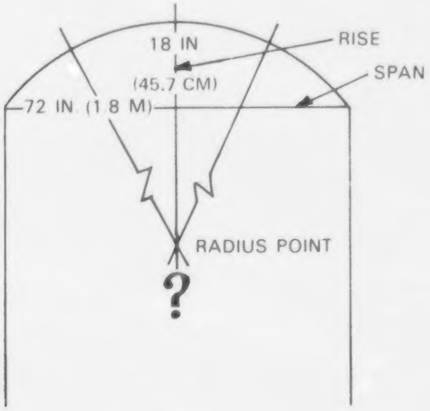
Fig. E-76. Setting tile on intrados of arch

Determining the Radius Point (Alternative Method)

The accurate layout of centers is essential to the proper construction of arches. By using the span, rise, and radius, the tilesetter can lay out a center. The procedures for laying out the various types of arches are different, and each type must be drawn in strict accordance with plan dimensions and accepted trade practices. If the arch is to serve its planned function, the center first must be drawn correctly on the plywood pattern.

The curvature of the arch and the angle for cutting the tiles cannot be drawn or located accurately until the radius of the arch is known. Some plans give the dimensions for the span and the rise but do not show the dimension for the radius. When the dimensions for the span and rise are known, the radius can be determined for roman, segmental, and other arches that have one radius point.

One method of determining the radius is illustrated in the following sketch.



The radius is determined as follows:

1. Divide span by 2 (72 ÷ 2 = 36)
2. Multiply product by itself (36 × 36 = 1,296)
3. Divide product by rise (1,296 ÷ 18 = 72)
4. Add answer and rise (72 + 18 = 90)
5. Divide answer by 2 (90 ÷ 2 = 45)

The radius for this arch is 45 inches (1.1 metres).

UNIT E — SPECIALIZED JOBS

TOPIC 9 — CURVED ARCHES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. A pin and piece of string can be used to lay out a(n) 1 arch. 1. __________
2. The span of an elliptical arch is called the 2 axis of the ellipse. 2. __________
3. When an arch contains half of a complete circle, it is called a(n) 3 arch. 3. __________
4. The rise of an arch usually is equal to 4 the span. 4. __________
5. The curve of a segmental arch has a(n) 5 radius. 5. __________
6. The three-centered arch is a form of a(n) 6 arch. 6. __________
7. In setting tile on an arch, a radius board may be used if the arch is 7 . 7. __________
8. The soffit and 8 may be floated with a template. 8. __________
9. The bullnose trim on the outer and inner curves should be placed so that the grout lines match those of the 9 tiles. 9. __________
10. Gothic arches are often set with a(n) 10 at the center. 10. __________

UNIT E — SPECIALIZED JOBS

TOPIC 10 — DOMES

This topic is planned to provide answers to the following questions:

- **How are domes prepared for tilework?**
- **What tools are needed for floating a dome?**
- **How are templates constructed?**

Domes and vaults, like arches, are designed to receive large downward pressures at a point at the top and transform those pressures into lateral thrusts toward the base. They are sometimes used when the architect wishes to convey an impression of dignity and formality.

Tilework on flat ceilings is a common tilesetting job, but the tilesetter may also be called upon to work on vaulted ceilings. The tilesetter needs to have experience in layout and job operations to do a competent tile job on such ceilings. Therefore, this topic includes information on constructing templates and floating the inner and outer areas of a dome. The actual tilesetting procedures after floating vary from one job to the other and are not discussed in this topic.

Making Templates for Interior Domes

To illustrate this topic, the project shown in Fig. E-77 is used. It is a fountain niche with a circular back reaching to the top of the ceiling and finishing flush with the wall line. The ceiling is a circular half dome. (Fig. E-78 is a cross section of the domed ceiling shown in Fig. E-77.)

The working procedures for this particular job are as follows:

1. Use a band saw to cut the templates to the correct form and radius required for floating both the scratch and float coats.
2. Bend or mold a ground strip of wood or casting plaster around the back of the niche, and level it at the points from which the spring line of the dome begins.
3. Float the scratch and float coats as needed.
4. Wedge a 2 by 4 inch (5.1 by 10.2 centimetre) board between the two sides of the fountain.
5. On the lower side of the template, drill a small hole at its center to accommodate a dowel.
6. Fasten a piece of wood with a hole of the same size at the apex of the arch and dome to receive the dowel at the upper or top edge of the template.

The three "riding points" for the template are as follows: the upper dowel, the lower dowel, and the back edge of the template. The template is correctly notched to ride on the ground or runner strip.

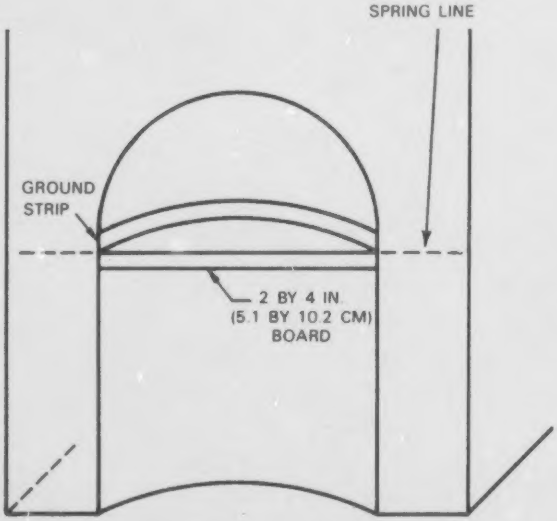


Fig. E-77. Fountain niche with a circular back

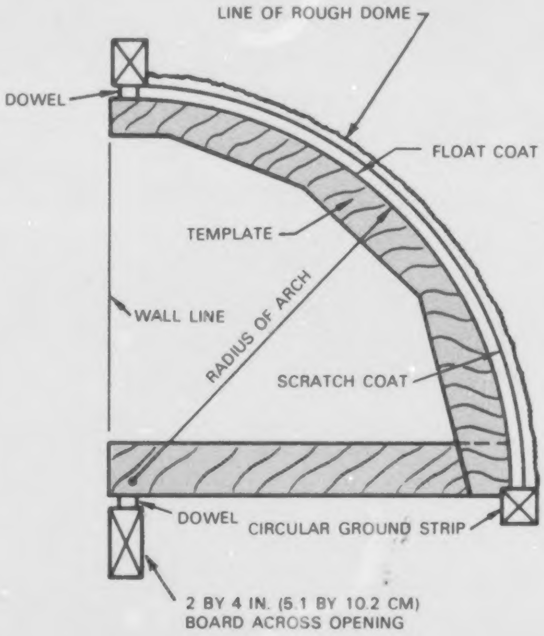


Fig. E-78. Cross section of interior dome

Floating the Interior Dome

An interior dome, such as the one in E-79, is floated as follows:

1. Make a template to fit the correct radius of the float coat.
2. Tack a ½-inch (1.3-centimetre) strip of lattice on the curved edge to provide a float for the scratch coat.
3. Remove the strip to restore the template radius to that of the setting bed.
4. After floating the dome, tack small exposed brads along the template at desired intervals to scribe level circles of ever-narrowing radii. These circles can be used as parallels to check the level of the tiles.

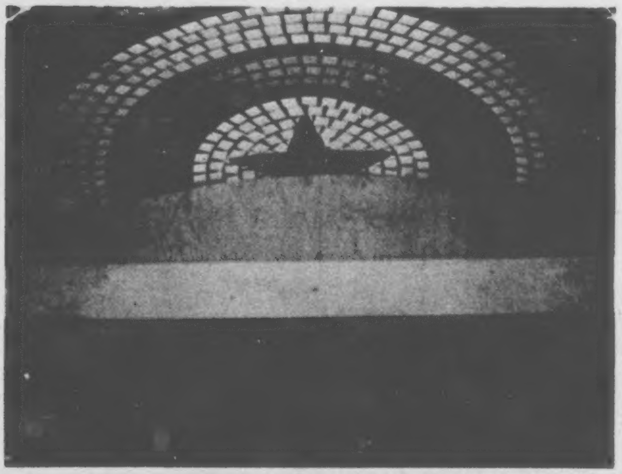
Floating the Exterior Dome

The procedure for floating the outer area of this same dome is the reverse of that for an interior dome so far as the cutting of the template is concerned. Because the "riding points" have been reduced to two, exceptional care must be taken to hold this template exactly vertical at all times (Fig. E-80). An example of a large exterior dome is shown in Fig. E-81.

Floating Large Domes

On large domes, interior or exterior, groins made of hard mud or plaster screeds must sometimes be used (Fig. E-82). The following procedure is recommended:

1. Spot 1-inch (2.5-centimetre) screeds on the scratch coat at the desired distance apart along the circular ground strip.
2. Use a template to run the screeds to the apex of the dome.
3. Use a smaller template of the same radius to float the setting bed. Cut this template so that it spans at least two screeds at the ground strip. Be sure that the motion while floating conforms to the radial line. Do this by keeping the float in such a position that it always spans at least two screeds.
4. Remove the hard screeds after floating is completed.



See color reproduction on page 131.

Fig. E-79. Shower dome being constructed

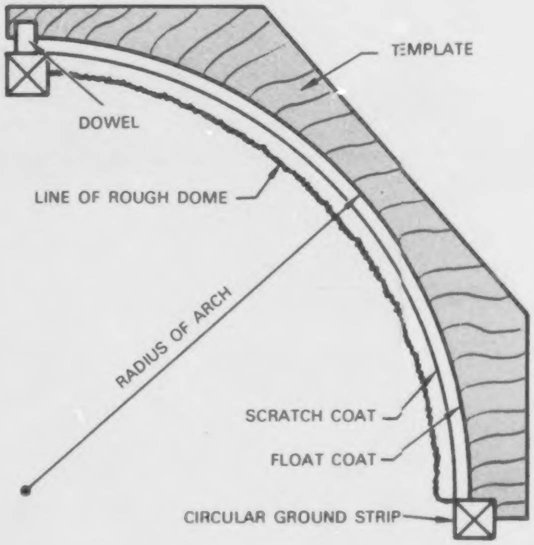


Fig. E-80. Exterior half dome

See color reproduction on page 132.

Fig. E-81. Example of a large dome (St. Vincent's Catholic Church, Los Angeles)

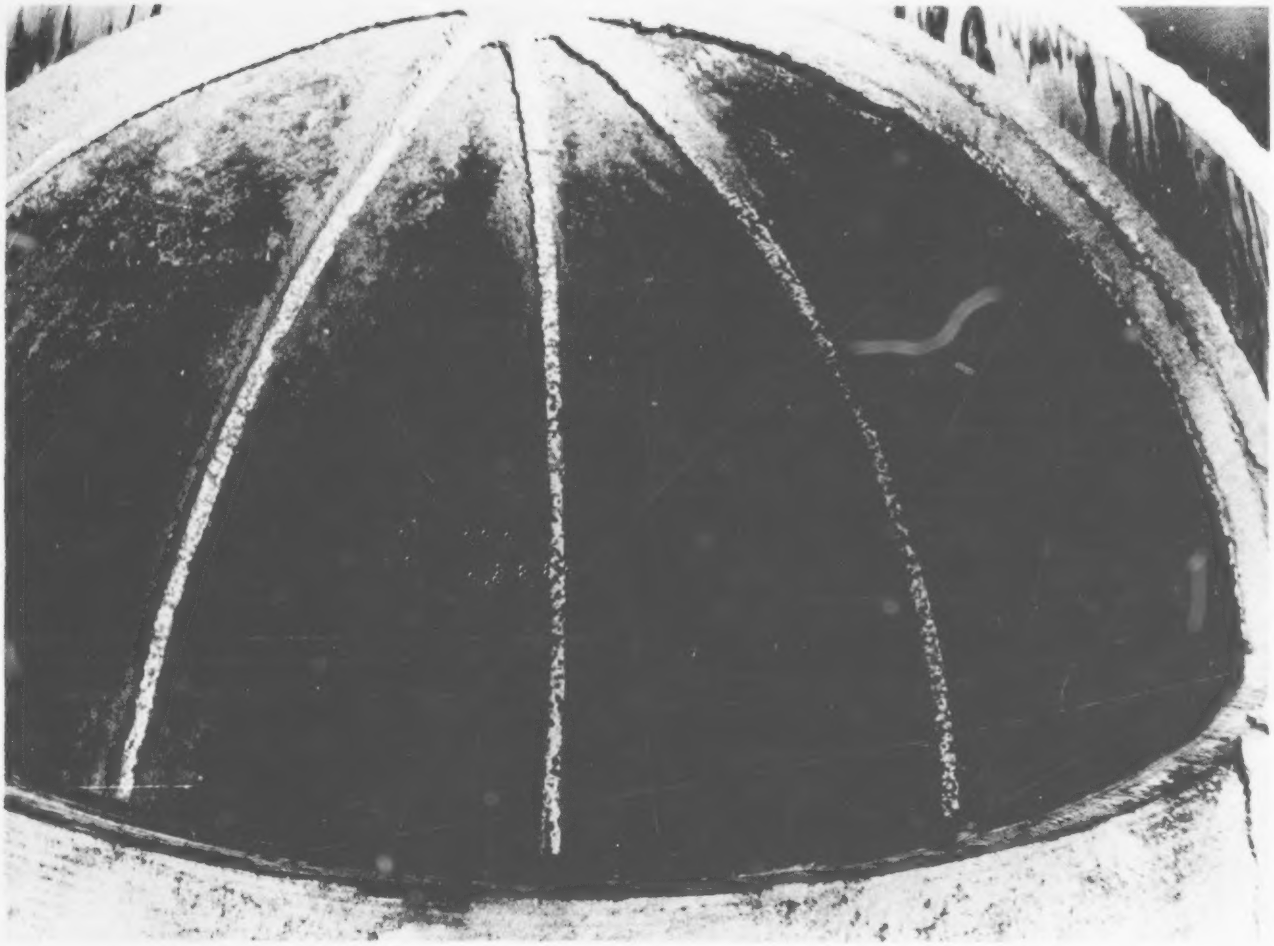


Fig. E-82. Hard screed groins used for floating a large dome

UNIT E — SPECIALIZED JOBS

TOPIC 10 — DOMES

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The template required for floating the scratch and ___1___ coats is band sawed to the proper form and radius. — 1. ________
2. The template for the inside of a dome has ___2___ riding points. — 2. ________
3. A ground strip of wood or ___3___ ___4___ is bent or molded around the back of the niche. — 3. ________ 4. ________
4. A 2 by 4 inch (5.1 by 10.2 centimetre) board is wedged between the two ___5___ of the fountain. — 5. ________
5. A template is made to fit the correct ___6___ of the float coat. — 6. ________
6. After the setting bed has been floated, small ___7___ should be tacked along the template. — 7. ________
7. The brads ___8___ level circles of ever-narrowing radii. — 8. ________
8. The circles can be used as ___9___ to check the level of the ___10___ . — 9. ________ 10. ________
9. Groins made of ___11___ ___12___ or ___13___ ___14___ must be used on large domes. — 11. ________ 12. ________ 13. ________ 14. ________
10. When an exterior dome is being floated, the template must be ___15___ at all times. — 15. ________

UNIT E — SPECIALIZED JOBS

TOPIC 11 — CIRCULAR WALLS

This topic is planned to provide answers to the following questions.

- **What procedures are used to float true circular walls?**
- **How are contoured walls floated?**

Although many tilesetters shy away from working on walls that are not flat, the apprentice will find that working on circular walls is not as difficult as it seems. A correctly prepared and tiled circular wall installed in a shower enclosure or an entrance way is a credit to the skill of the tilesetter. Graceful shapes, including French curves, which have no fixed centers for pivoting a radius, are a challenge to any tilesetter.

Two procedures are used for floating a true circular shower or circular room (Fig. E-83).

Floating True Circular Walls (Method 1)

True circular walls can be floated as follows:

1. Find the exact center of the floor, and establish a fixed point.
2. Use a plumb bob to duplicate this point on the ceiling.
3. Obtain a rough measurement of the radius, and determine the circumference ($C = 2\pi r$).
4. Lay out the tile in a straight line on a flat surface. Use the circumference to count out the tiles. Measure the exact length of the number of tiles that give a measurement closest to the circumference. If the actual circumference and the tiles laid out do not match, the formula $R = C \div 2\pi$ is used to determine the new radius.
5. Cut a small stick to the length of the radius plus the thickness of the tile used. This is the exact radius of the setting bed; use this radius to make a template of ¾-inch (1.9-centimetre) plywood.
6. Set float strips at the radial distance from the center points, using the small stick to measure at intervals determined by the length of the template (Fig. E-84).
7. Check the float strips to see that they are plumb.
8. After setting the strips, float the setting bed in the same manner as described earlier.
9. Place water level marks at eye level on the float strips. A mud screed at the floor line may then be set by using the template parallel to the water level marks.

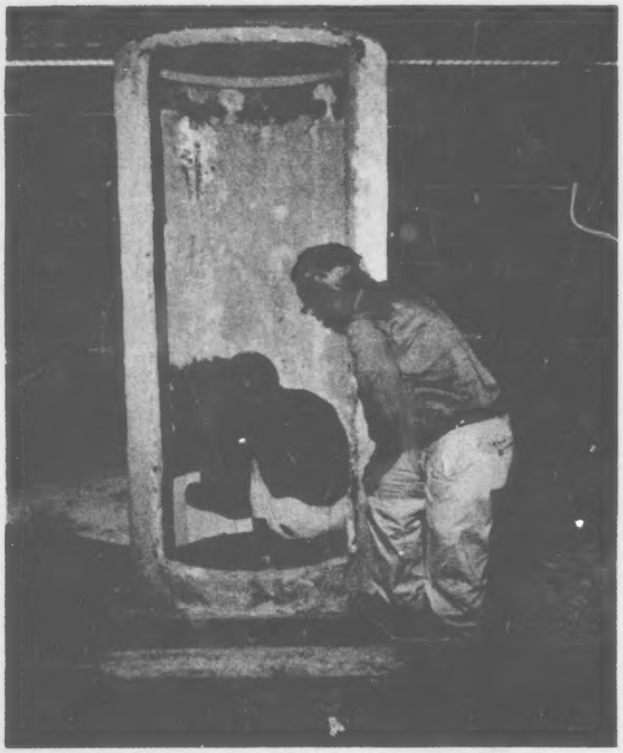


Fig. E-83. Constructing a circular wall

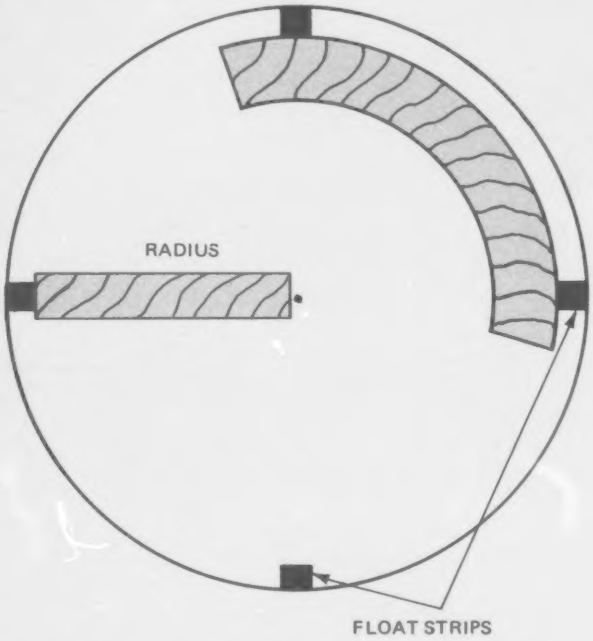


Fig. E-84. Float strips set from center points

Floating True Circular Walls (Method 2)

Another procedure for floating true circular walls is as follows:

1. Obtain the center point in the floor and on the ceiling in the same way as was described in method 1.
2. After the center points have been established, wedge a pole or pipe between the floor and the ceiling, using the center marks for alignment of the pole.
3. Cut a 1 by 4 inch (2.5 by 10.2 centimetre) radius board as described in method 1, and make sure that the two ends are cut so they are square.
4. Cut a piece of tin from a coffee can to a size approximately 4 by 6 inches (10 by 15 centimetres). Attach this as a strap to the radius board. Insert a clamp, nails, or screws so the other end can be fastened around the center pole or pipe (Fig. E-85).
5. Mix "hot mud," using lumnite or casting plaster.
6. Float two horizontal bands of the mud on the wall, one 8 inches (20.3 centimetres) up from the floor and one 8 inches (20.3 centimetres) down from the ceiling. Using the radius board as a swing or compass, make the bands of mud approximately 4 inches (10 centimetres) wide.
7. When the mud is firm, remove the center pole.
8. Cut away the sides of the bands of mud to leave a 1½-inch (3.8-centimetre) screed.
9. When the screeds are hard, float the setting bed with a long straightedge held perpendicular to the wall while rodding up and down. *THE HARD SCREEDS MUST BE REMOVED.*

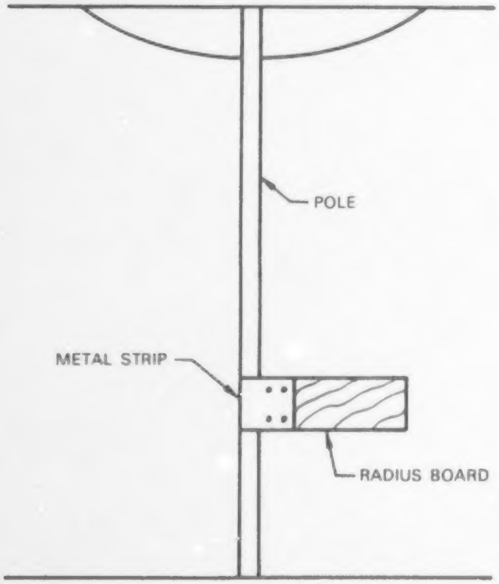


Fig. E-85. Pole and radius board

Floating Large Circular Walls (Method 1)

Large circular walls that must be perfect can be prepared either with a precut template or with hard horizontal screeds. However, floating the hard screeds on large circular walls is sometimes quite difficult. A flawless circular wall can be produced as follows:

1. Obtain a length of tie wire, two small turnbuckles, a 4-inch (10.2-centimetre) iron dowel or bolt, and a stick about 10 inches (25 centimetres) long.
2. Find the true center point on the floor, and place the dowel or bolt at this point. Attach it firmly so that it will withstand tension.
3. Draw a level chalk line on the scratch coat 4 inches (10.2 centimetres) from the top of the wall and another line about 12 inches (30 centimetres) from the floor.
4. Drill holes in the stick, near the top and bottom, to receive the wire.
5. Fasten a 6-inch (15-centimetre) length of wire to each hole, and fasten a turnbuckle at the opposite end of each length. Fasten one end of a 10-inch (25-centimetre) length of wire to the opposite side of each of the turnbuckles so as to form an adjustable bridle. Then, fasten this bridle to a longer wire that extends out from the dowel in the center of the room.
6. Float or mold a 2 by 10 inch (5 by 25 centimetre) plumb strip of "hot mud" to the desired thickness of the setting bed at one end of each of the level lines. This strip is to be used as an adjusting screed (Fig. E-86).

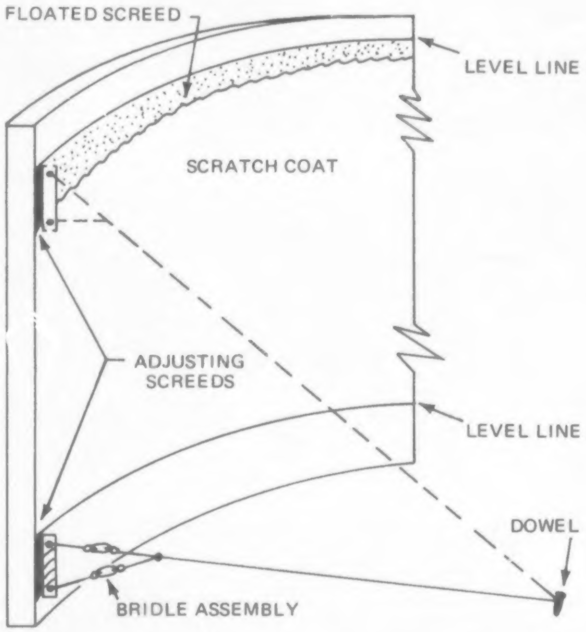


Fig. E-86. Hard screed floated on circular wall

7. When the mortar is firm, adjust the assembly to the upper adjusting screed. Trowel a band of mortar slightly below the top level line. Proceed to float, using the assembly as a compass so that the top edge of the wood is kept in line with the level line at all times (Fig. E-87).
8. After floating the top screed, detach and readjust the assembly to the adjusting screed at the lower level line. Float the lower screed (Fig. E-88).

This operation should result in two perfect bands of mortar. The bands should be rimmed so as to leave a 2-inch (5.1-centimetre) hard screed. Then the surface should be floated vertically.

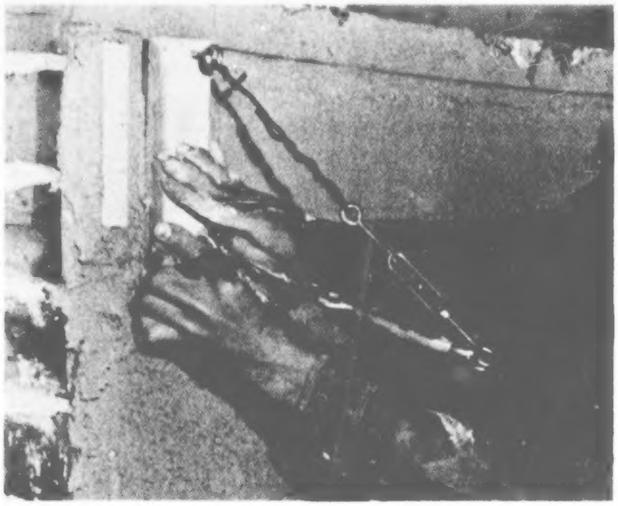


Fig. E-87. Using wire and bridle assembly to set top screed on circular wall

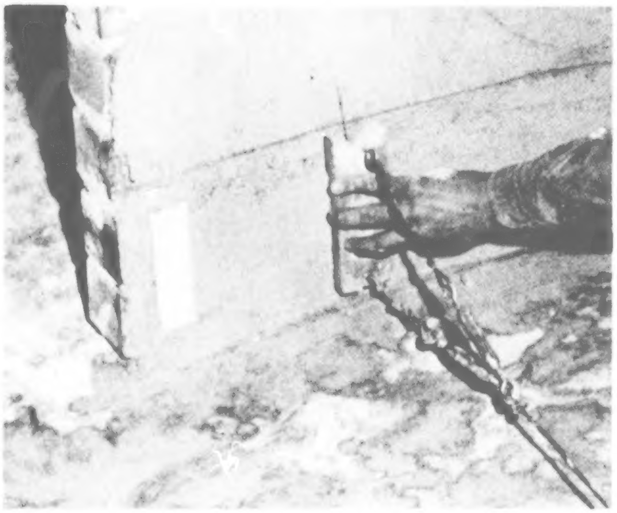


Fig. E-88. Using wire and bridle assembly to set lower screed on circular wall

Floating Large Circular Walls (Method 2)

A second method of floating a large circular wall has been developed (Fig. E-89). This method of floating is as follows:

1. Obtain a length of wire, two small turnbuckles, a 4-inch (10-centimetre) iron dowel or bolt, and a straightedge equal to the height of the wall.
2. Find the true center point on the floor, and place the dowel or bolt at this point.
3. Attach one short wire and turnbuckle 6 inches (15 centimetres) from the top of the straightedge, and attach one short wire and turnbuckle 6 inches (15 centimetres) from the bottom. Connect each turnbuckle to the dowel with wire.
4. Place a level on the inner edge, and adjust the turnbuckles until the edge is plumb and at the correct distance from the wall for a setting bed.
5. Float the wall to the approximate thickness required.
6. Tape or hold a level to one side of the edge.
7. Hold the side of the edge plumb; with pressure away from center, cut mortar.
8. Refrain from vertical motion of edge.

Floating Contoured Walls

Contoured walls are constructed of curves with varying centers. The recommended method of floating these walls is as follows:

1. Cut two ¼ by 1¼ inch (0.6 by 3.2 centimetre) lattice strips to the length of the wall, and lay

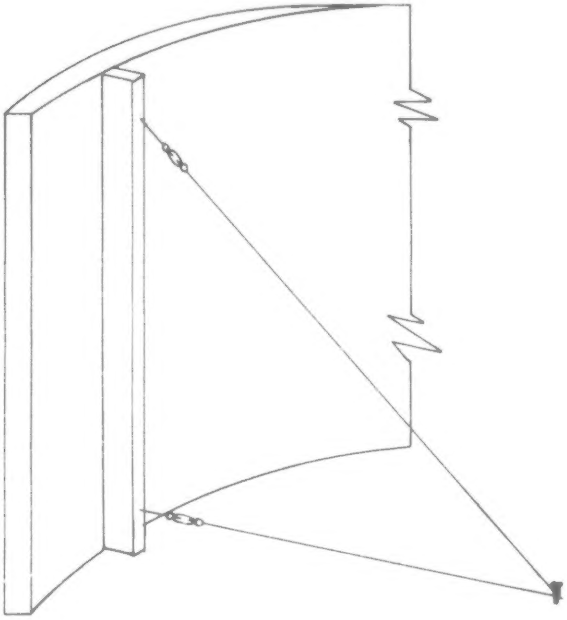


Fig. E-89. Floating curved wall with straightedge them on a flat surface side by side. Mark the two strips at intervals of 12 inches (30.5 centimetres) from left to right, and wet them thoroughly so that they will bend readily.

2. Trowel a horizontal band of mortar about 8 inches (20 centimetres) down from the top of the wall. Maintain a uniform thickness of not less than ½ inch (1.3 centimetres) from the scratch coat, and extend the band of mortar all the way across the wall (Fig. E-90).
3. Place the wet lattice on the mortar from the starting line with the marked side visible; tap the lattice lightly along its length to embed the material. Seal the edges at the top and bottom to lock them in place.
4. Repeat this procedure on the lower part of the wall 8 inches (20 centimetres) above the floor. Check the plumb with a straightedge, using the 12-inch (30.5-centimetre) marks to check the lower strip against the upper strip (Fig. E-91). Then, seal the strip.

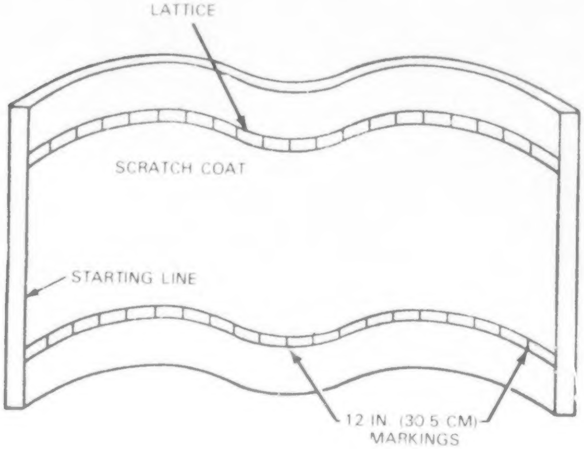


Fig. E-90. Contoured wall

5. Float the surface, rodding in a direction perpendicular to that of the screeds.

Placing Wall-Supporting Screeds

Screeds for supporting tile to be set on circular walls can be placed as follows:

1. Set two float strips at a height that would be correct if the floor were to be floated.
2. Apply screed mortar around the wall.
3. After tamping down the screed, float it with a straightedge lying flat.
4. Trim the screeds so as to leave a 2-inch (5-centimetre) rim.

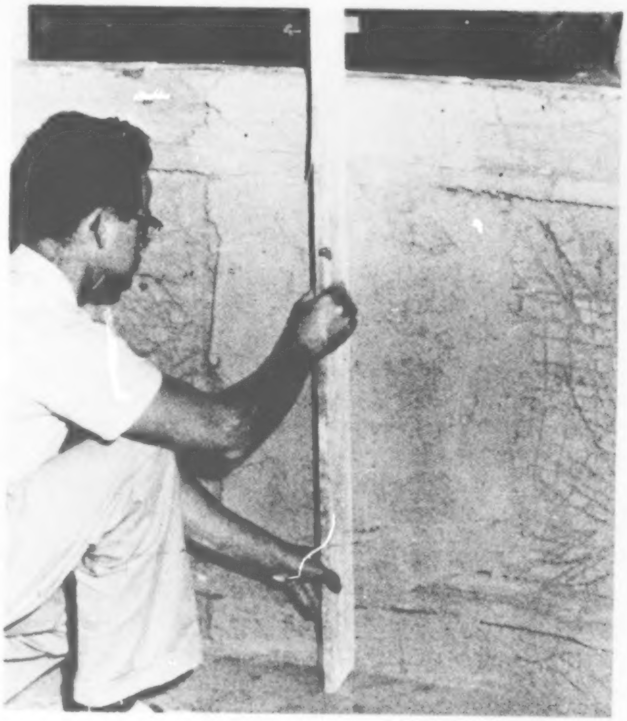


Fig. E-91. Checking plumb with a straightedge

UNIT E — SPECIALIZED JOBS

TOPIC 11 — CIRCULAR WALLS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. Lattice strips should be thoroughly _1_ so that they will bend readily. 1. ________

2. Float strips must be _2_. 2. ________

3. When a circular wall is floated, the _3_ point is found on the floor. 3. ________

4. Large circular walls can be prepared either with a precut template or with hard horizontal _4_. 4. ________

5. The radius template is made of plywood that is _5_ inch(es) thick. 5. ________

TOPIC 12 — CIRCULAR COLUMNS

This topic is planned to provide answers to the following questions:

- **How are circular columns prepared for floating?**
- **What are the recommended methods of floating circular columns?**
- **How is ceramic mosaic tile applied to a circular column?**

The preparation of the surface of a circular column to receive tile is a fascinating procedure, and a true artisan should enjoy the challenges it presents. When the instructions outlined in this topic are followed, the apprentice tilesetter will be able to perform a creditable tile job on any circular column.

Preparing Columns

Circular columns can be prepared for the floating bed by either of two methods (Fig. E-92). These methods are the following:

1. Set vertical wood float strips plumb at four points on the column, directly opposite one another, and then float with a template in the usual manner.
2. Apply casting plaster or cement mortar horizontally on the column, and mold with a template; then, make a series of hard screeds of equal size. Iron bands can be used as screeds. These are ⅛ by 1 inch (0.3 by 2.5 centimetres) in two half sections, and they are set in place with a template.

The circumference of the finished column is the most important measurement in this operation, and the tilesetter should take into consideration the dimensions of the tile to be used.

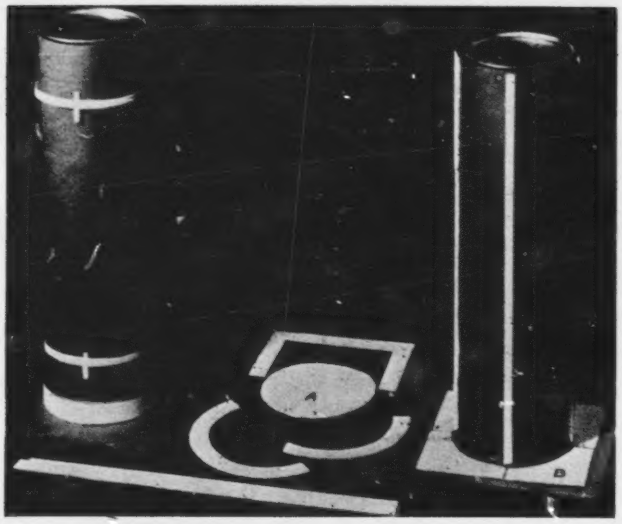


Fig. E-92. Model columns showing two methods of preparing for floating bed

Floating Columns

Circular columns can be floated by two different methods.

Method 1

The steps in method 1 are as follows:

1. After obtaining the correct finished circumference, figure the radius in accordance with the following formula:

$$R = \frac{C}{2\pi} - \text{thickness of tile}$$

2. Apply the dimensions of this radius to making a pattern from 15-pound (7-kilogram) felt. Both A and B in Fig. E-93 will be used as patterns.
3. Center A will serve as a guide for cutting the floating template, which should be approximately one-third the circumference (Fig. E-94). The template should be made of ¾-inch (1.9-centimetre) plywood.
4. Mark the outer pattern B into four equal parts (Fig. E-95).
5. Fasten pattern B to the floor at the base of the column with tacks or masking tape. Ensure that the setting bed is uniformly thick.

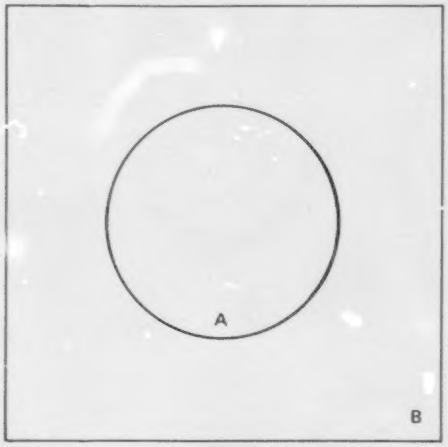


Fig. E-93. Pattern A

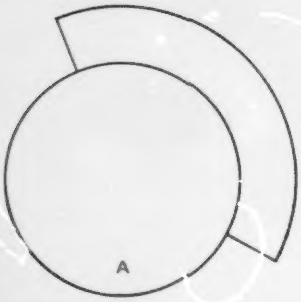


Fig. E-94. Third-round template

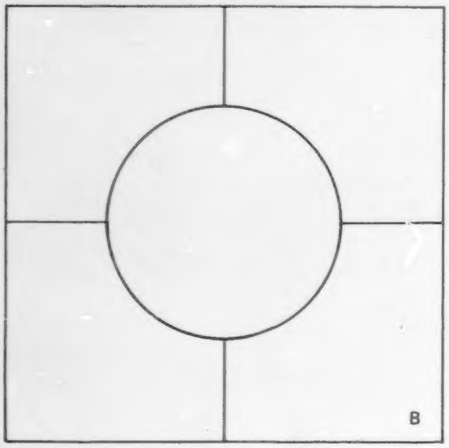


Fig. E-95. Pattern B

6. Set float strips plumb from the inside edge of the pattern, using quarter marks on the cutout for positioning (Fig. E-96). The strips must be absolutely plumb on both lines.
7. Check the parallel points by making a three-sided caliper of 1 by 4 inch (2.5 by 10.2 centimetre) lumber with the use of cutout A (Fig. E-97).
8. When parallel points have been checked, proceed to make a dry run. Mix enough hot mud by adding casting plaster for a 5-minute set, and float a 6-inch (15.2-centimetre) band at the base of the column, using the template for floating.
9. Obtain a 1½-inch (3.8-centimetre) wide rubber band that is long enough to go around the column. (You can make one from an old tire tube.) When the hot mud has set, tie on the rubber band about halfway up on the mud.
10. Slip ceramic mosaic tile cut into 3-inch (7.6-centimetre) strips between the band and the mud all around, thus making sure that the tile will come out even (Fig. E-98). Be sure to allow an expansion joint in the tile for beating in, thereby avoiding a buckle in the finished tile.

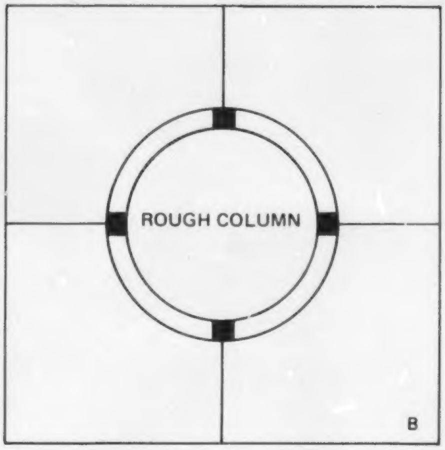


Fig. E-96. Float strips set plumb from pattern

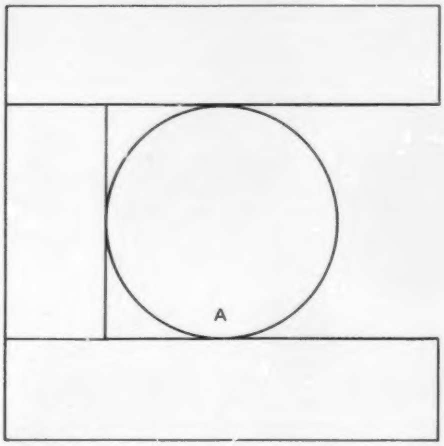


Fig. E-97. Parallel checked with a three-sided caliper

11. When this dry run checks out, remove the hot mud, but leave the float strips, and proceed in the usual fashion.

Method 2

The second method of floating is used when a base or similar object has been installed previously, thereby preventing the use of pattern B described above. The steps in method 2 are as follows:

1. Set plaster spots approximately 1 by 3 inches (3 by 8 centimetres) at intervals of every 7 feet (2.1 metres) starting 8 inches (20.3 centimetres) above the base on the rough column; and plumb on two lines opposite each other (Fig. E-99).
2. Check the parallel points with calipers as described in the first method and shown in Fig. E-97.

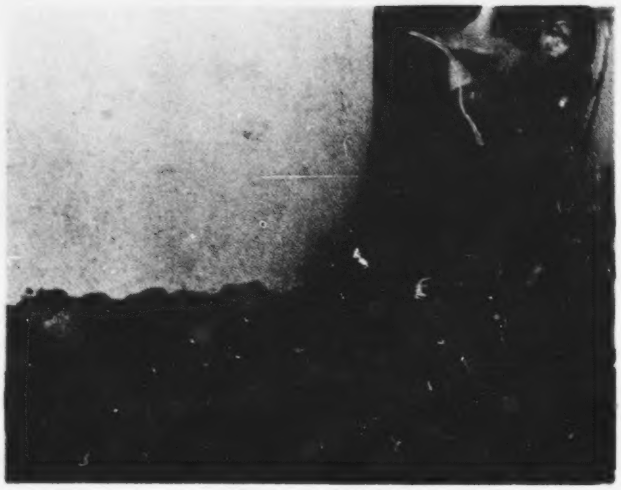


Fig. E-98. Making test run with tiles on column

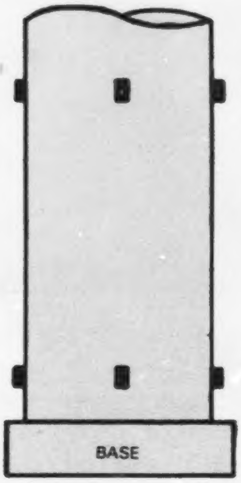


Fig. E-99. Plaster spots set on rough column

3. Using cutout A, make a half-round template of ¾-inch (1.9-centimetre) plywood (Fig. E-100).
4. With this template, spin a 3-inch (8-centimetre) band of mud on the bottom plaster spots.
5. When the mud is quite firm, make a dry run as explained in the first method.
6. When the dry run checks correctly, continue spinning on remaining spots; then cut away the mud, leaving a 1½-inch (3.8-centimetre) collar. To make a plaster band or collar, grease the inside edge of the template with cup grease or lard.
7. Mold a firm casting plaster mix to the template, which is held horizontally on the spots.
8. Trim the top and bottom. Wait 5 minutes, and then spin the template away, leaving a ¾-inch (1.9-centimetre) band.
9. Repeat this procedure on the opposite side of the column, following the steps outlined above.
10. After the collars are hard, apply the setting bed, rodding with an 8-foot (2.4-metre) straightedge held so that it is perpendicular. (Plaster collars harden in 1 hour; cement collars harden in 24 hours.) Hard screeds must be removed.

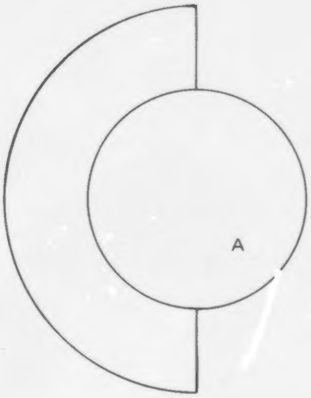


Fig. E-100. Half-round template

When rounded iron bands are being used, the tilesetter should follow the above methods, but allow for the thickness of the metal. The bands used for this purpose are ⅛ by 1 inch (0.3 by 2.5 centimetres). They are divided into two sections and are set in place with a template.

Leveling

The procedure that is used by tilesetters to mark a level line around a plumb and parallel column is as follows:

1. Cut a piece of 36-inch (91.4-centimetre) tar paper that will be one and one-half times the circumference.
2. Apply the paper around the floated mortar bed at any spot you desire, securing it with a rubber band or string as described previously.
3. Adjust the paper lap line at both the top and bottom to form a cylinder.
4. Scribe or mark a line, using the paper edge as your guide (Fig. E-101). This may also be used as a starting line for tile when a column is out of plumb.

Applying Tile

Applying ceramic mosaic to a column that is less than 36 inches (91.4 centimetres) in diameter sometimes presents a problem in the bending of the sheets to conform to the radius. To solve this problem, the tilesetter should take the following steps:

1. Cut a square of ¾-inch (1.9-centimetre) plywood 6 inches (15 centimetres) wider than the diameter.
2. Use cutout A as a pattern to make a round hole in the center.
3. Cut the plywood in half, and spread the two pieces 24 inches (61 centimetres) apart with the half circle side up. Then, proceed to line the inside radius with sheet metal, wood lath, or small strips of wood, forming a "cradle."
4. Lay ceramic mosaic sheets in the cradle. Apply sand and pure coat in the regular manner, carefully holding the formed sheets in position. Remove the mosaic sheets from the cradle, and apply them to the setting bed that has been coated with pure coat. Using a rubber mallet, tap the tile in place with a small beating block held in a perpendicular position.

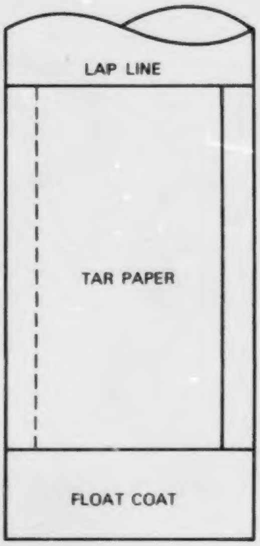


Fig. E-101. Level line marked around column

UNIT E — SPECIALIZED JOBS

TOPIC 12 — CIRCULAR COLUMNS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The most important measurement in tiling columns is the 1 of the finished column. 1. ________
2. When horizontal screeds are used to prepare for the floating bed on a column, they are molded with a(n) 2 . 2. ________
3. When vertical wood strips are used for floating a column, the tilesetter sets them plumb on 3 side(s) of the column. 3. ________
4. When vertical float strips are applied, the radius is figured 4 the thickness of the tile used. 4. ________
5. The center of the pattern is used as a guide for cutting the floating 5 . 5. ________
6. The outer pattern is divided into 6 equal parts and secured to the floor at the base of the column. 6. ________
7. Float strips are set plumb from the 7 edge of the pattern. 7. ________
8. The parallel points can be checked with a(n) 8 -sided wood caliper. 8. ________
9. Plaster collars harden in 9 hour(s). 9. ________
10. When estimating the circumference of a finished column, the tilesetter must allow for the 10 of the tile to be used. 10. ________

TOPIC 13 — SWIMMING POOLS

This topic is planned to provide answers to the following questions:

- **What is the recommended procedure for laying out a swimming pool?**
- **How is swimming pool tile set?**
- **How is coping tile set on a residential pool?**

Tiling a swimming pool is a highly specialized job, in which a premium is placed on details and accurate work. The type of tile used must be impervious to chemically treated water, body oils, and weather conditions. The tilework must be durable. Tilework may be installed in a swimming pool by any one of a number of different methods, but the procedures recommended in this topic have proved to be efficient and accurate. A minimum amount of final cleanup is required when these procedures are followed.

As part of the preparation for a job, the tilesetters should study the plans, carefully noting the details of the pool, such as grade elevation, scum gutter installation, lifeline anchors, and depth markers They can then determine the best starting point for the work. They should also check to see that a safe scaffold is in place, that all tile accessories are available, and that the correct tiles are present.

Layout and Sketching

The following procedure is recommended for the layout and sketching of the swimming pool:

1. Make a full-size detail sketch of the curb, scum gutter, and handrail (Fig. E-102). Show all measurements and bench marks.
2. Check the pool to make sure that everything is in accordance with the plans, giving special attention to seeing that walls are square, parallel, and plumb; surfaces are true; all holes in the concrete, lifelines, polo-net and foul-line anchors, ladder holes, and other accessories are as indicated; scum gutter drains slope correctly; and water inlets and outlets project from the walls to receive tile and are of uniform length.

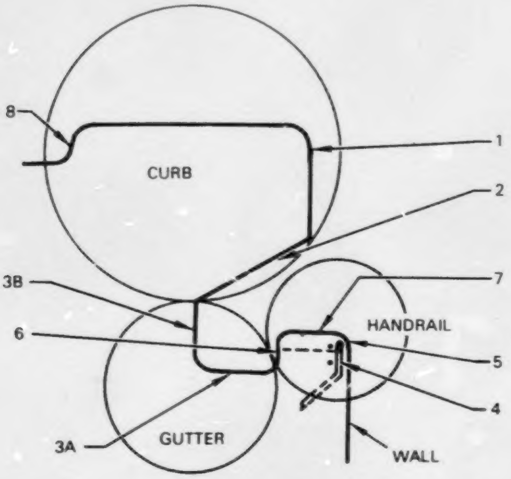


Fig. E-102. Detail of swimming pool curb

Setting of Tile

Before any actual operations can be initiated, grade or bench marks must be established. These may be either 12 inches (30.5 centimetres) down on the walls of the pool or on top of the curb. Either way, they should be not more than 6 feet (1.8 metres) apart.

The next step is to complete the scratch coat and then the plumb coat. The bench marks should be protected during the time the scratch coat is being scored, and the scratch coat should be kept wet until it has thoroughly set.

The order of procedure in setting tile, zone by zone, is shown in Fig. E-102. The chief advantage of starting to work at the top of the pool and proceeding down is that the tilesetter does not have to work above already completed tilework. This procedure also facilitates the establishment of an accurate water line. If the handrail were completed before the gutter and curb faces, it would be in the way and thus slow the work considerably. The following steps are recommended:

1. Lay the face of the curb (surface No. 1 in Fig. E-102). Be sure the surface is level and true, because the other members are established from it. Install the depth and racing lane markers at the same time.
2. Float mortar on the bottom of the curb (surface No. 2 in Fig. E-102), and lay tile, using template No. 1 (Fig. E-103). This template, which is made

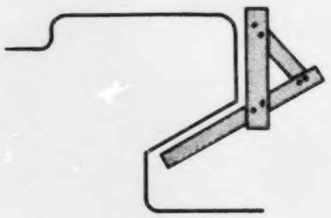


Fig. E-103. Template No. 1

from the full-scale detail sketch, rides the face of the curb.

3. Float mortar on the back surface of the gutter (surface No. 3B in Fig. 102). Set float strips by using template No. 2, holding it against the face of the curb (Fig. E-104).
4. Float mortar to the correct slope between drains on the bottom surface of the gutter (surface No. 3A in Fig. E-102). Floating this surface before laying tile on the back of the gutter eliminates the need for a separate screed to set the tile on the back of the gutter. The whole gutter bottom can be floated in no more time than is required to float this screed, and a lot of cleaning can be avoided if the entire area is floated before any of it has been tiled.
5. Lay tile on the bottom surface of the gutter.
6. Lay tile on the back surface of the gutter. However, if the coved shoe base is set against the gutter back rather than flat on the bottom of the gutter, the tilesetter may reverse steps 5 and 6 and lay the tile on the back of the gutter first.

Handrail and Wall

The handrail and wall should be formed as follows:

1. Form the rough handrail (No. 4 in Fig. E-102) by bending vertical dowel rods to the proper vertical and horizontal dimensions, using template No. 3 (Fig. E-105). Bend rods from the back of the gutter to the center of the handrail.

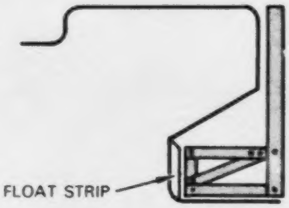


Fig. E-104. Template No. 2

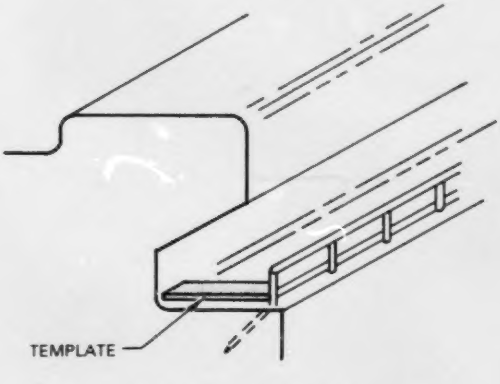


Fig. E-105. Template No. 3

2. Tie continuous horizontal rods at top and center of each dowel.
3. Cover dowel rods and horizontal rods with galvanized wire lath.
4. Apply the scratch coat.
5. If the bench marks are on the wall, use template No. 4 to move the bench marks to the top of the curb (Fig. E-106). This template must be held absolutely plumb in transferring the marks; any other position will shorten the distance and make the transferred marks inaccurate.
6. Float mortar on the wall to the spring line of the curved part of the wall; lay tile on this. Install all lines and markers at the same time, taking care to keep the handrail true to grade within ⅛ inch (0.3 centimetre) (surface No. 5 in Fig. E-102).
7. After establishing the new grade line, float mortar on the back surface of the handrail (surface No. 6 in Fig. E-102). Lay tile, using template No. 5 (Fig. E-107).

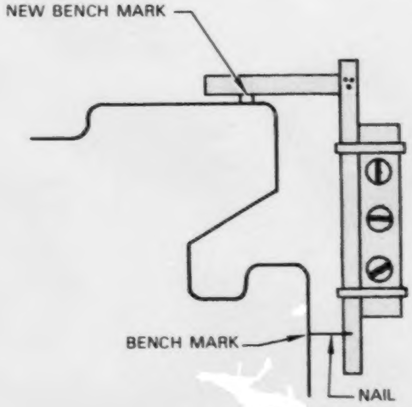


Fig. E-106. Template No. 4

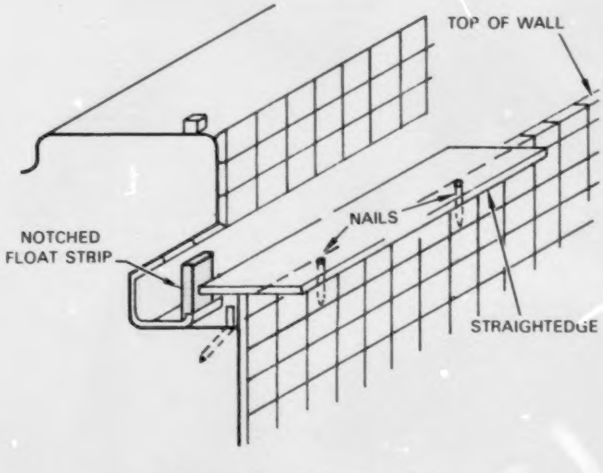


Fig. E-107. Template No. 5

8. Float mortar on the top surface of the handrail (surface No. 7 in Fig. E-102). Use template No. 6 for this step (Fig. E-108). Because the top of the handrail is usually only ½ to 2 inches (1.3 to 5.1 centimetres) above the water line, this surface must be absolutely level. It is the most critical leveling job in working on a swimming pool.

Completion of Curb

The curb of the pool should be completed as follows:

1. Set float strips and screed spots on the back surface of the curb (surface No. 8 in Fig. E-102). Use template No. 7 (Fig. E-109).
2. Float mortar on the back surface of the curb, and lay tile on this surface.
3. Float mortar on the curb deck, and lay tile on this surface.

Completion of Sides

A scaffold is needed to float and lay tiles on the sides. The work is begun at the top of the sides, and the scaffold is lowered as work progresses. The recommended steps are as follows:

1. Using the plan of the pool, establish points corresponding to A, B, and C on Fig. E-110.
2. Make a template to fit the radius of curvature at the bottom of the pool at each of these points.
3. Run mud screeds from points A, B, and C, allowing them to set before proceeding.
4. Screeds that run from points A, B, and C are too far apart to float from, but cutting templates to run screeds at every convenient place on the curved walls would be impractical. Therefore, holding a wire taut and moving it along the hard screeds, cut and form additional screeds at the desired places between points D and E on the shallow end of the pool, A and B and B and C on the long side walls, and F and G on the deep end walls. Sidewalls and end walls must be continued to form an accurate intersection in the corners of the pool.
5. Float the mortar, and set the tile; lower the scaffold whenever necessary for convenient reaching.

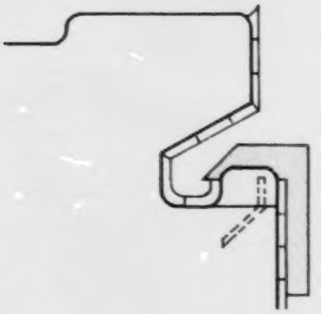


Fig. E-108. Template No. 6

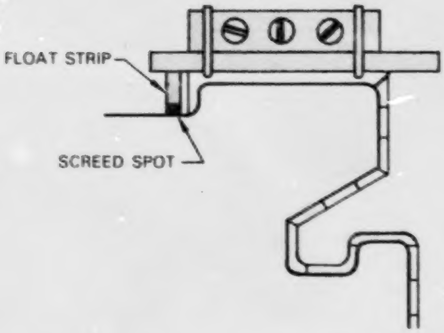


Fig. E-109. Template No. 7

Racing Lanes

The tilesetter often has difficulty in keeping the racing lanes straight because of the ramping of the floors of the pool. The following procedure is a simple and sure way to accomplish this job:

1. Fasten a 2 by 4 inch (5.1 by 10.2 centimetre) board securely at each end of the pool (Fig. E-111).
2. Lay out racing lanes (or any other lines to be extended) on these pieces, as at H, J, K, and H', J', and K'.
3. Pull a wire tight from one end of the pool to the other, over the center of the racing lane.

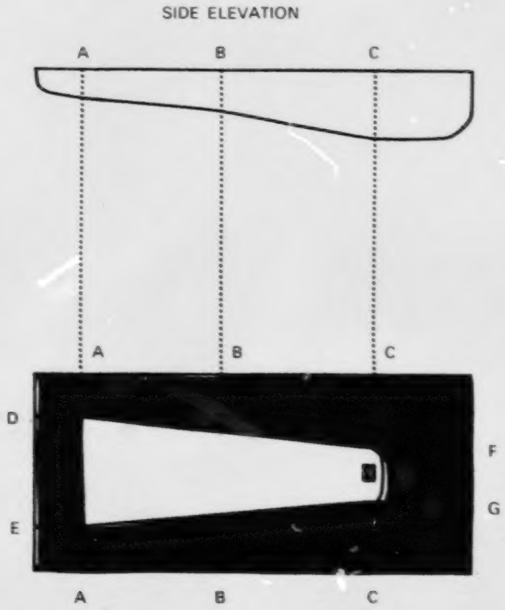


Fig. E-110. Plan of swimming pool

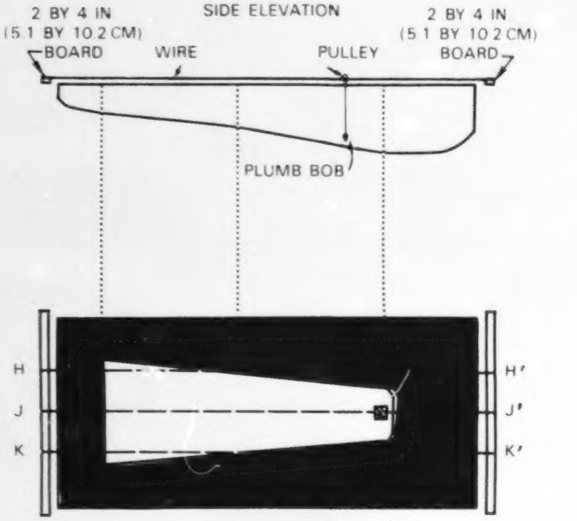


Fig. E-111. Plan of swimming pool, showing racing lanes

4. Fasten a plumb bob to this wire so it can be adjusted for height and moved along the wire from one end to the other. This can be done with a pulley or safety pin.
5. Adjust the plumb bob for height, and move it along the wire, marking the bottom and the walls of the pool. These marks should be made close enough to ensure that the lanes are straight.

Residential Pools

Most residential pools have a coping and narrow band of tile at the water line. Both the coping and the band of tile are installed by the tilesetter. The recommended procedures for installing the coping and tile are as follows:

1. Check the sides of the pool for straightness and the top of the pool where the coping is to be set for levelness. Mark the in and out and high and low areas.
2. Ensure that the coping is level. Using a water level, establish level marks on the sides of the pool 8 to 10 feet (2.4 to 3 metres) apart and 3 to 6 inches (7.6 to 15.2 centimetres) below the point where the bottom edge of the tile is to be (Fig. E-112).
3. Cut a gauging strip, which is held at the water level marks, to establish the correct level for the screed sticks to float the mortar for the coping (Fig. E-112).
4. Float the mortar for the coping (Fig. E-113).

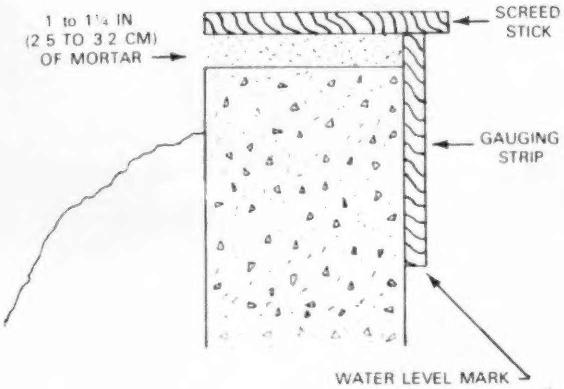


Fig. E-112. Establishing the correct level

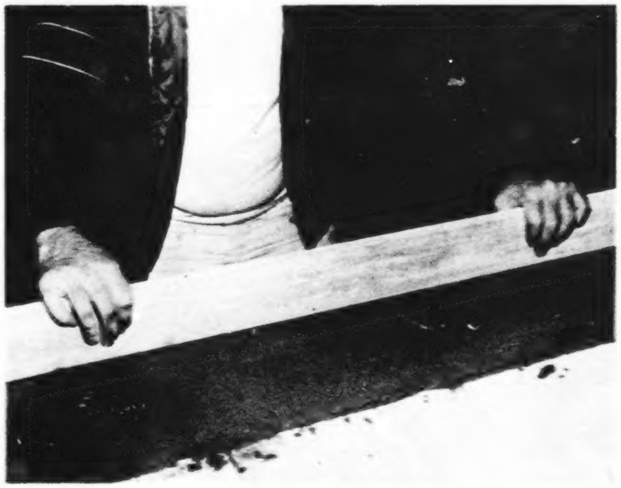


Fig. E-113. Floating the mortar for the coping

5. Trowel the surface, and set the coping in place (Figs. E-114 and E-115). The coping is set ¾ inch (1.9 centimetres) beyond the side of the pool to allow for tile and mortar (Fig. E-116).
6. Float the mortar for the tile using the roller-skate template (Figs. E-117 and E-118). The roller-skate template can be used with a small level to ensure that the mortar and tile under the coping are plumb (Fig. E-119).
7. Set the tile under the coping with a pure coat of portland cement (Fig. E-120).
8. Grout the joints of the coping. Use a copper metal mask (Figs. E-121, E-122, and E-123).
9. Grout the tile; the joints should be fully compacted.

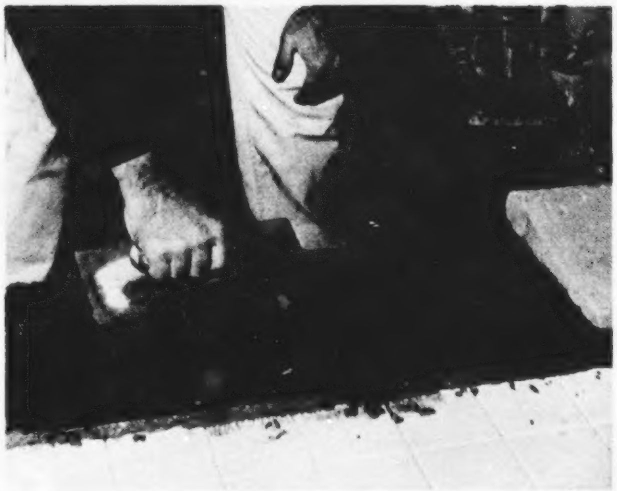


Fig. E-114. Troweling the surface of the mortar

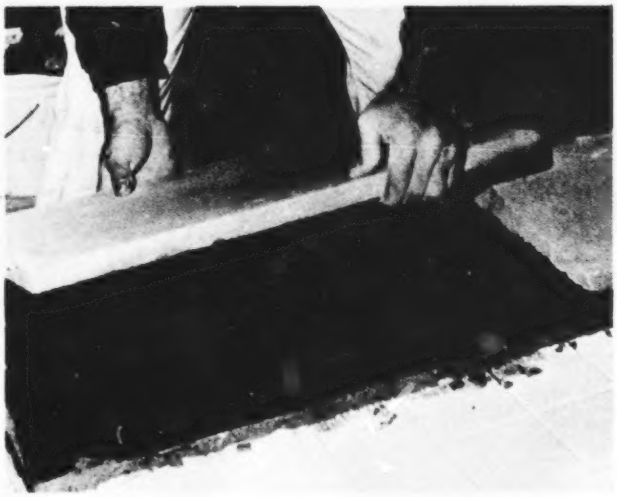


Fig. E-115. Setting the coping

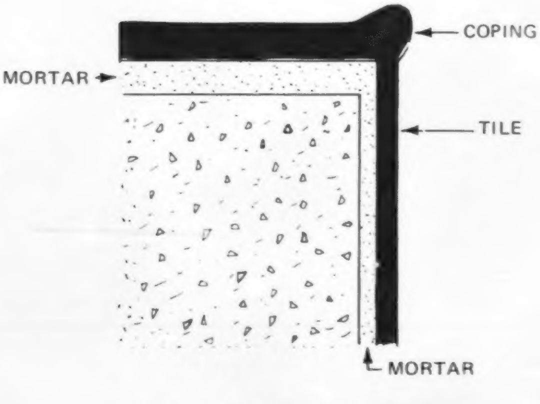

COPING
MORTAR
TILE
MORTAR

Fig. E-116. Placement of coping

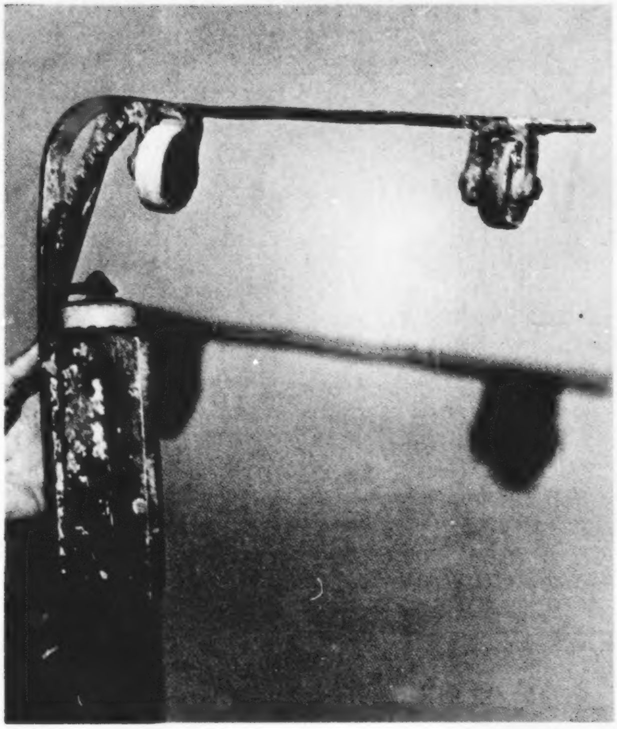


Fig. E-117. Roller-skate template

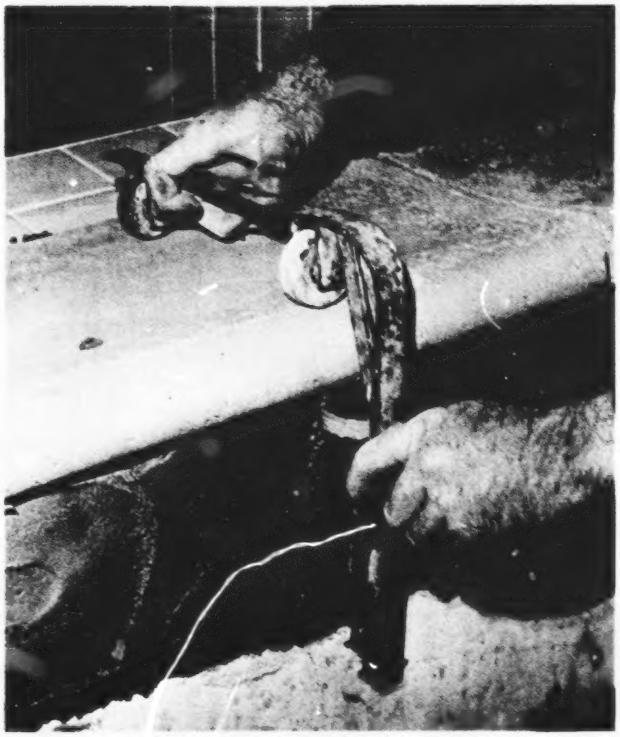


Fig. E-118. Floating the mortar with a roller-skate template

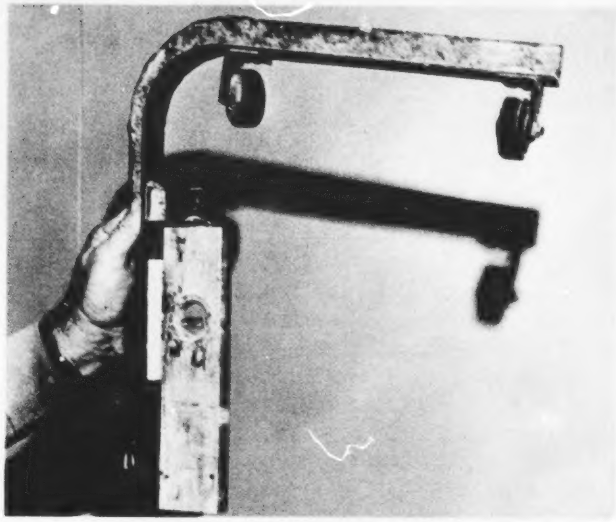


Fig. E-119. Roller-skate template with level

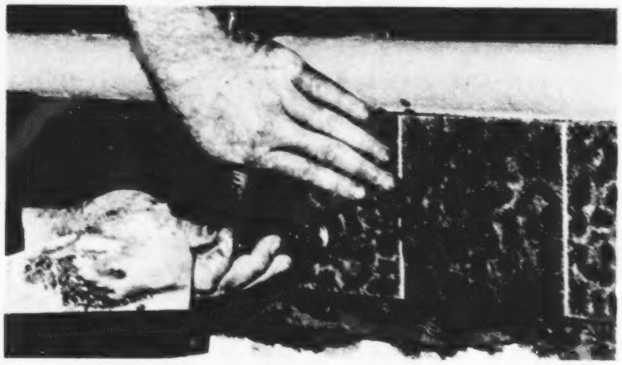


Fig. E-120. Setting the tile under the coping

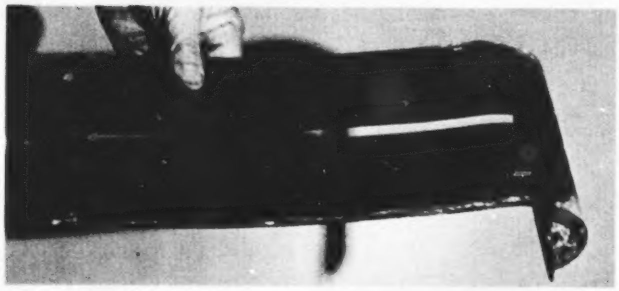


Fig. E-121. Copper metal mask

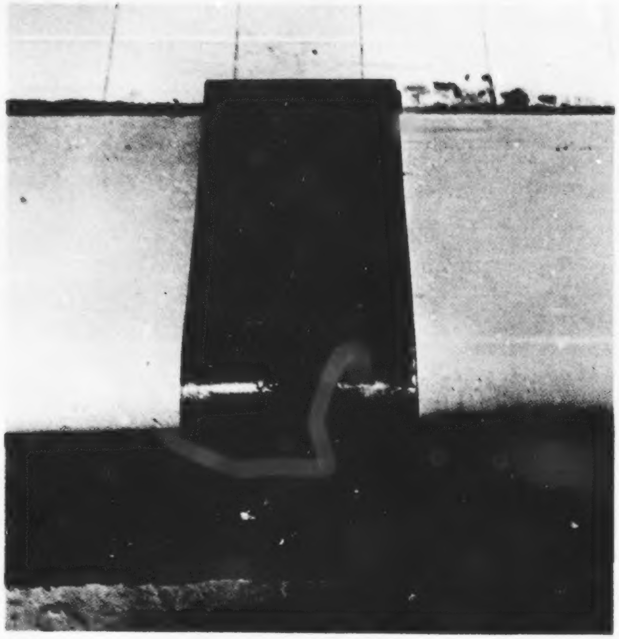


Fig. E-122. Grouting with a copper metal mask

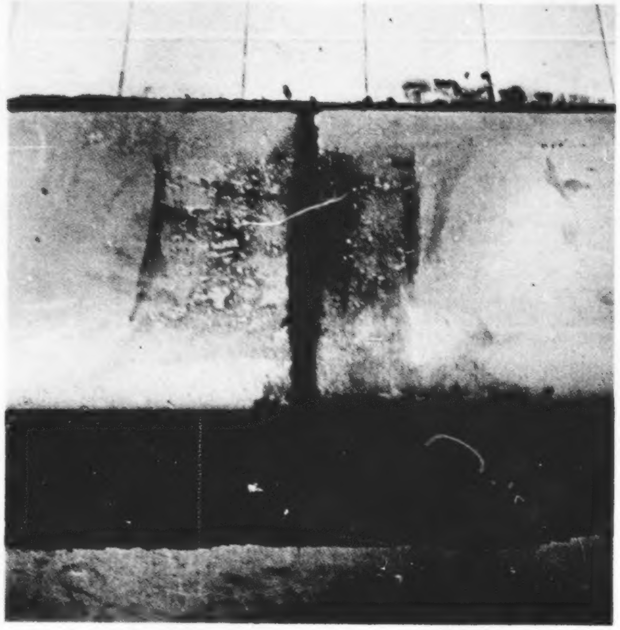


Fig. E-123. Finished joint

UNIT E — SPECIALIZED JOBS

TOPIC 13 — SWIMMING POOLS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The tilesetter should first study the swimming pool _1_ and carefully note the details. — 1. ________

2. A full-size detail sketch is made of the _2_, _3_, and scum gutter. — 2. ________ 3. ________

3. In general, tiles are set from the _4_ of the pool toward the _5_. — 4. ________ 5. ________

4. Grade marks may be established at about _6_ inch(es) down on the walls of the pool. — 6. ________

5. At the time the face of the curb is laid, _7_ markers and _8_ lane markers are laid also. — 7. ________ 8. ________

6. When being established, grade marks should be not more than _9_ feet apart. — 9. ________

7. The purpose of checking the sides of the pool is to find any _10_ or _11_ areas. — 10. ________ 11. ________

8. Water level marks are set _12_ to _13_ feet apart. — 12. ________ 13. ________

9. The mortar for the _14_ is floated first. — 14. ________

10. The coping projects a minimum of _15_ inch(es) beyond the side of the pool. — 15. ________

TOPIC 14 — FOUNTAINS

This topic is planned to provide answers to the following questions:

- **How is a fountain laid out for tilework?**
- **What are the recommended procedures for tiling a fountain?**

A fountain is generally the focal point of a patio, sunroom, park, or garden. It should be a work of art that beautifies and enlivens the area (Figs. E-124 and E-125). Therefore, it should be installed with efficiency and accuracy. The construction of a fountain can give the apprentice tilesetter experience in several phases of tilesetting, including work on layout, arch forms, and tile installation.

Every fountain installation requires some variations in procedure. The procedures listed in this topic are based on the plans illustrated in this topic; they are also based on principles of good layout. These principles can be applied to the construction of any fountain. The methods described here allow the tilesetter to improvise so as to make the job easier and more accurate.

Setting the Corners

The first step in working on a fountain such as the one illustrated in Fig. E-126 is to complete the walls of the square corners. The recommended procedures are as follows:

1. Study the plans and specifications, and check the rough concrete form of the fountain. Determine the correct size of the installed structure. Allow for the addition of tile and mortar on the inside and outside of the fountain. The overall rough dimensions should be 2 inches (5.1 centimetres) less than the finish dimensions to the outside of the concrete form and 2 inches (5.1 centimetres) more than the finish dimensions to the inside. The concrete form itself is 4 inches (10.2 centimetres) wide.
2. Apply the scratch coat and the plumb coat (if necessary).
3. Determine the floor or walk level of the fountain, and set mortar screeds about 2 inches (5.1 centimetres) wide inside and outside the fountain.
4. Build the wooden frame to inside finish dimensions. It must be perfectly square (Fig. E-126).
5. Place the wooden square inside the fountain. Strike diagonals to find the center point of the fountain; then, determine the centerlines, and check them against the sides of the wooden square with a framing square to ensure that they are perpendicular.
6. Set float strips inside the fountain. Set them so as to allow for the thickness of the tile between the strip and the wooden square.
7. Float the inside corners of the walls, checking the openings for the arcs to ensure that they conform to the finished dimensions on the plans (Fig. E-127). Set tiles on the inside corners.

See color reproduction on page 133.

Fig. E-124. Tiled fountain (private residence)

See color reproduction on page 134.

Fig. E-125. Circular fountain (Los Angeles City Mall)

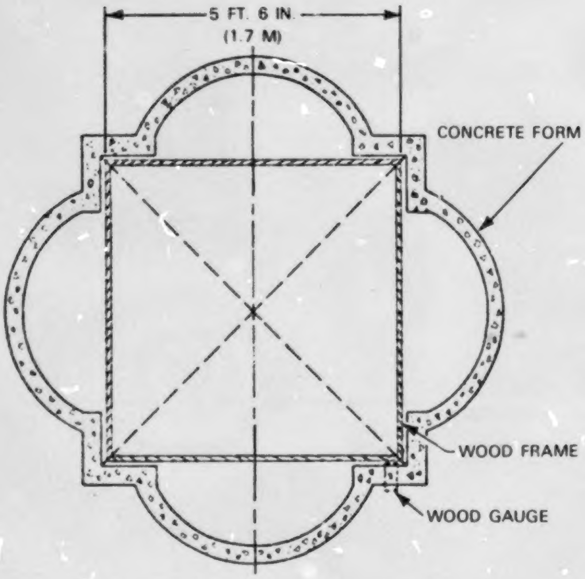


Fig. E-126. Rough dimensions of fountain

8. Set float strips on the outside of the fountain. In this fountain the finish dimension of the wall is 6 inches (15.2 centimetres). The thickness of tile on the outside curb measures ⅜ inch (1 centimetre). Subtracting the thickness of the tile from the finish dimension gives 5⅝ inches (14.3 centimetres), the distance between the face of the tile on the inside curb and the face of the float strip on the outside curb. Therefore, make a wood gauge 5⅝ inches (14.3 centimetres) long.
9. Float the outside corners, and set the tiles.

Setting the Curved Walls

The layout of a curved fountain wall is similar to that of a curved arch. With a fountain, the shapes are laid out on a plan view, but the methods are the same as those used for laying out arches in an elevation view. The recommended procedures are as follows:

1. Draw a full-size plan of the inside circular curb, checking the plans for the dimensions needed to lay out each segment. Then, extend the radius so as to draw in the outside of the curb. The thickness of the wall must be determined from the plans; in this fountain the thickness is 6 inches (15.2 centimetres) (Fig. E-128).
2. After the entire layout is completed, determine the cuts needed, and cut the tiles for the inside, top, and outside of the curb.
3. Construct a wood float for floating the curved wall (Fig. E-128). Maintain the center of the circle by placing a pin at the appropriate point in the wood support.
4. Float the inside and outside of the curbs, and set tile.

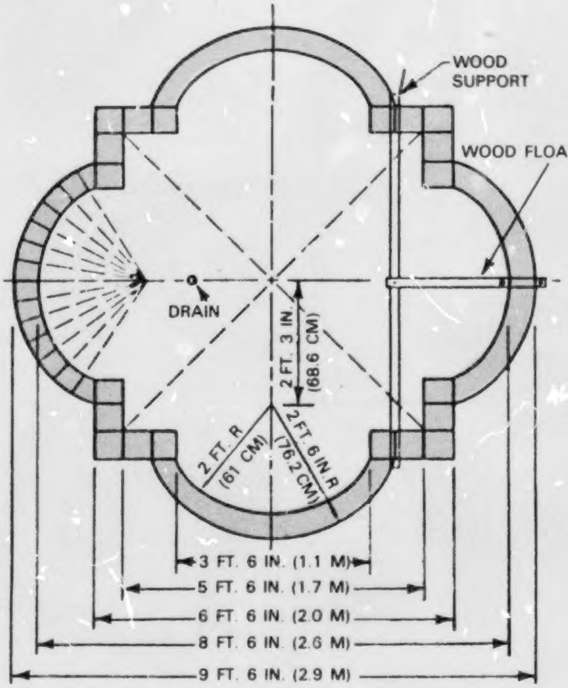


Fig. E-127. Finish dimensions of fountain

5. Float the tops of all the curbs, and set tile.
6. Grout all the joints.

Setting the Center Section

The center section is put in after the wall of the fountain is completed. Use the following procedure:

1. Set the forms around the water pipe (Fig. E-129). For this fountain the forms will be 4 by 4 by 6 inches (10.2 by 10.2 by 15.2 centimetres) and 16 by 16 by 5 inches (40.6 by 40.6 by 12.7 centimetres). Check to ensure that the forms are square with the inside walls of the fountain. Pour the concrete.
2. Float the surfaces, and set tile.
3. Lay the tile on the floor of the fountain in a straight or diagonal pattern. The floor must slope toward the drain.
4. Grout the remainder of the joints.

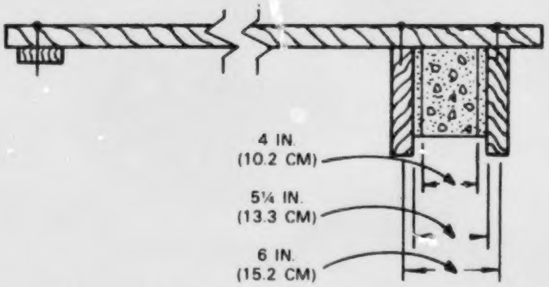


Fig. E-128. Detail of wood float on wall

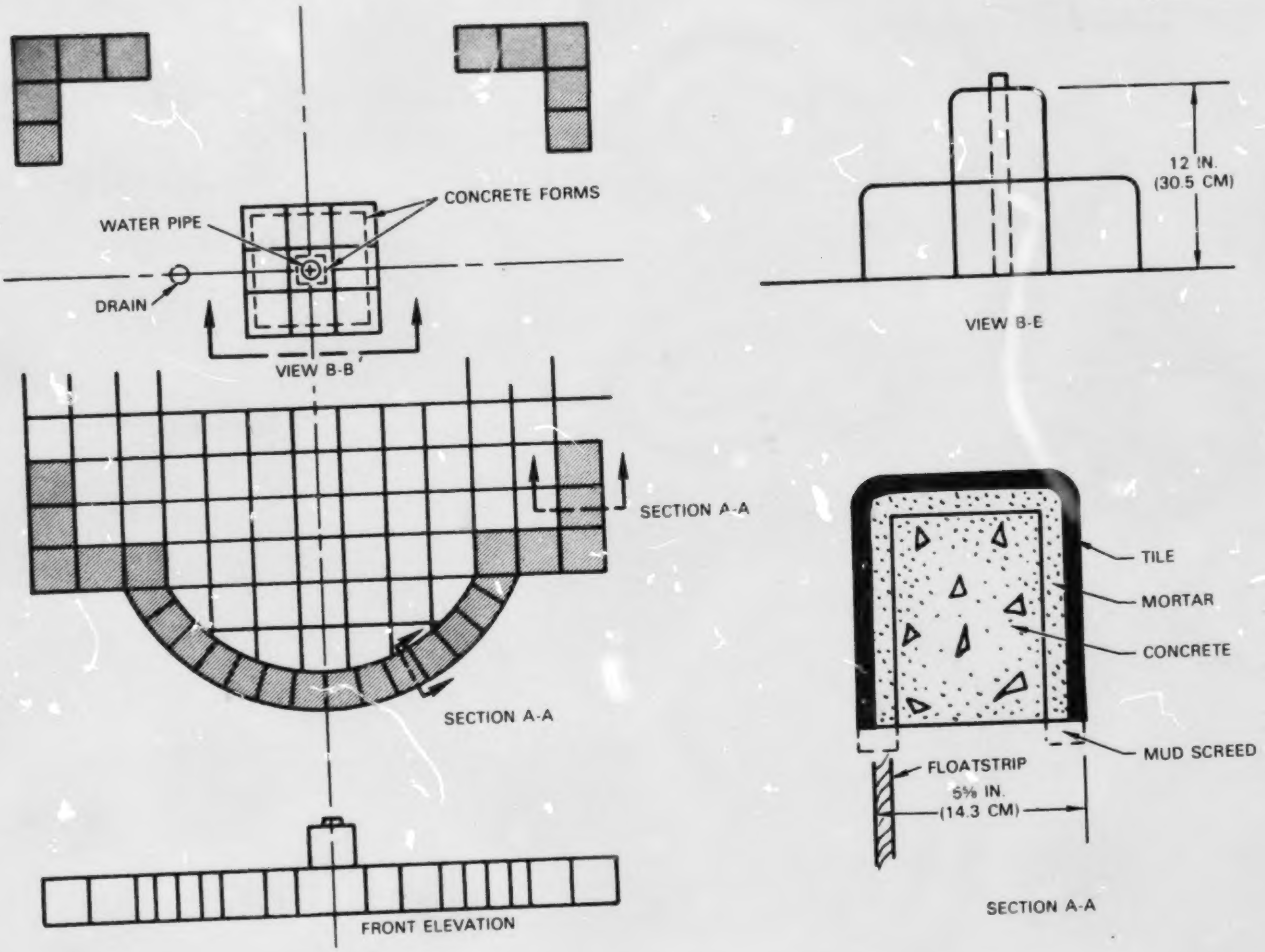

CONCRETE FORMS
WATER PIPE
DRAIN
VIEW B-B
SECTION A-A
SECTION A-A
FRONT ELEVATION
12 IN.
(30.5 CM)
VIEW B-B
TILE
MORTAR
CONCRETE
MUD SCREED
FLOATSTRIP
5⅝ IN.
(14.3 CM)
SECTION A-A

Fig. E-129. Straight-joint layout of fountain

UNIT E — SPECIALIZED JOBS

TOPIC 14 — FOUNTAINS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. When ⅜-inch (1-centimetre) tile is used, the outside rough dimensions of the structure can be estimated to be 1 inch(es) smaller than the 2 dimensions.

1. ________
2. ________

2. The purpose of finding the correct floor level is to set 3, which should be about 4 inch(es) wide.

3. ________
4. ________

3. After the dimensions have been checked, the next procedure in tiling a fountain is to apply the 5 6.

5. ________
6. ________

4. A wooden square built to fit inside the fountain is constructed to fit the 7 8 dimensions from the plans.

7. ________
8. ________

5. As soon as the wooden square is placed inside the fountain, the 9 of the fountain should be located.

9. ________

6. Float strips on the inside walls are set to allow for the 10 of the 11 between the strips and the square.

10. ________
11. ________

7. To determine the correct cuts for the circular curb, the tilesetter should prepare a(n) 12 - 13 14.

12 ________
13. ________
14. ________

8. The size of the wood gauge for floating the outside wall of the fountain is determined by subtracting the thickness of the 15 from the 16 17 of the wall.

15. ________
16. ________
17. ________

9. When the fountain walls are curved, the first surface on which to set tile is the 18 of the curbs.

18. ________

10. Mortar is floated on a curved wall by means of a(n) 19 20.

19. ________
20. ________

TOPIC 15 — TILE STAIRS

This topic is planned to provide answers to the following questions:

- **What are the different types of stairways?**
- **How is tile laid out on a stairway?**
- **What is the recommended method of tiling a stairway?**

Stairways usually are built in their rough form by a carpenter or cement mason. Sometimes, they are not built to receive tile, even though they are intended to be finished that way. The competent tilesetter should know from looking at the layout of a stairway if the construction is accurate and if sufficient clearance is provided for the tile that is to be set. Apprentice tilesetters must learn the basic terms and layout procedures involved, although they set tile over stairways that are designed and built by others.

Types of Stairways

The two most common types of stairways are straight stairways and platform stairways. Platform stairways have more than one flight of stairs, broken by a platform or landing. A straight stairway is shown in Fig. E-130. An "L" stairway with a quarter-turn landing is shown in Fig. E-131, and a "double L" stairway with two quarter-turn landings is shown in Fig. E-132. A "dogleg" stairway is U-shaped, with a half-turn landing (Fig. E-133). Circular stairs may be used in more costly homes or in public buildings. Circular stairways are shown in Figs. E-134 and E-135.

Stairways may be open or closed on one or both sides. An open stairway with a right-hand handrail is shown in Fig. E-136.

Spider Web Layout for a Circular Stairway

The tilesetter may have to align the joints of the winder stairs with the joints on the flier stairs. In Fig. E-134 an isometric projection, as viewed from point A of the staircase, is shown in view B. The winder threads are composed of three 30-degree angles. The three angles form a 90-degree angle to the lower riser

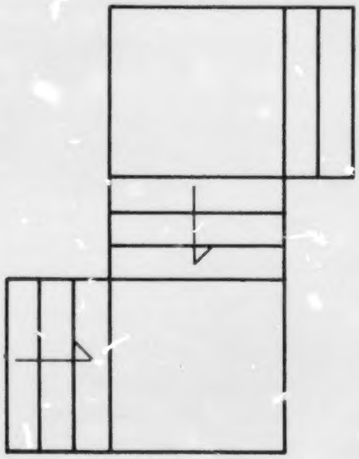


Fig. E-132. "Double L" stairway

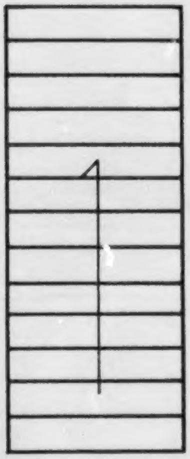


Fig. E-130. Straight stairway

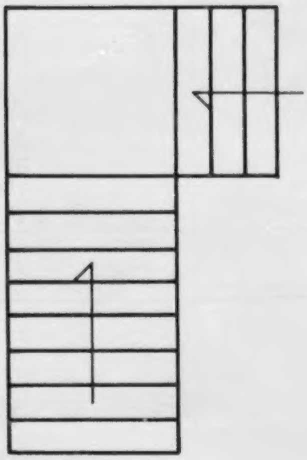


Fig. E-131. "L" stairway

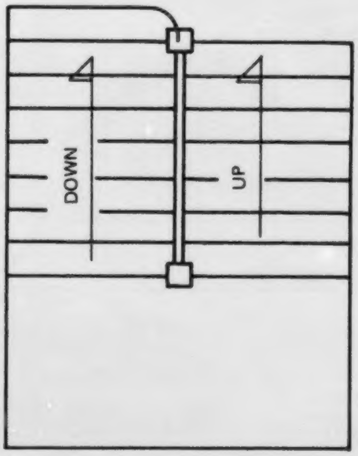


Fig. E-133. "Dogleg" stairway

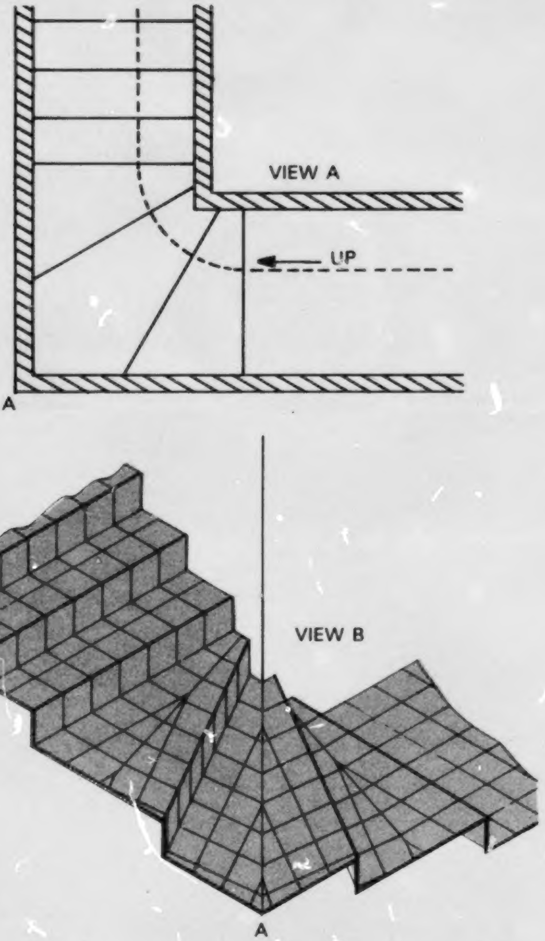


Fig. E-134. Circular stairway (type 1)

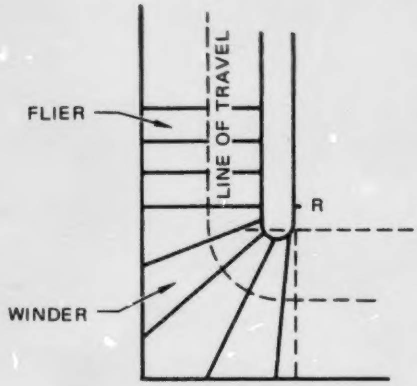


Fig. E-135. Circular stairway (type 2) showing flier and winder

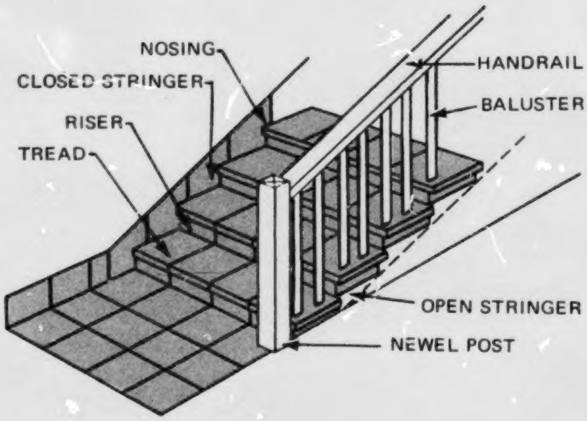


Fig. E-136. Stairway terminology

of the flier. A recommended method of aligning the joints of the winder stairs with the joints of the flier stairs is as follows:

1. Float the lower riser of the flier step as per layout.
2. Make a 30-degree template of plywood or any other suitable material.
3. Place the template on the tread with one edge against the lower riser of the flier. Float the riser face at the 30-degree angle.
4. Remove the template and place it on the next tread with one edge against the 30-degree riser. Then float the riser face at the 60-degree angle.
5. Repeat the procedure at the 90-degree riser face.
6. Mark a 15-degree angle radial line at the center of the 30-degree angle template.
7. Be sure that tiles on the lower riser of the flier step are set in accordance with the layout.
8. Place the template on top of the 30-degree tread. At 90 degrees to the face of the riser, mark joints on the template, stopping at the 15-degree radial line.
9. Mark joints at 90 degrees to the edge of the 30-degree nosing angle, stopping at the 15-degree radial line.
10. Use the template as a guide for the setting of the winder risers.
11. Use the template layout for the cutting and fitting of the stair tread tiles.
12. Ensure that the template layout is the same for all three angle treads.

NOTE: The nosing tile should be square to the adjacent lower riser. The back tread tiles should be square to the adjacent upper riser.

Stairway Terminology

The stairway parts described below are illustrated in Figs. E-135 and E-136.

Baluster

A baluster is a column or rod that is set vertically from the tread or the stringer to support the handrail. If the second-floor wellhole is open, balusters will also be set across its open edge to form a guardrail. When the balusters are placed directly on the treads, often two will be placed on each tread, the shorter one near the nosing baluster on the next tread. If the balusters are to be set outside the treads, two stringers must be provided. In this case the outside one is called the "face" stringer. The balusters fit into the space between the two stringers. Blocks are set into this space so as to form pockets into which the balusters fit.

Balustrade

A balustrade is a row of balusters topped by a rail.

Flier

A flier is any one of a flight of steps where the planes of the risers are parallel to each other and the treads are equal in width from end to end.

Flight

A flight is a continuous series of stairs from one landing or floor to the next.

Landing or Platform

A landing or platform is the level part of a stairway, deeper than a step, connecting one flight of stairs with another.

Newel Post

A newel post is the principal post at the foot of straight or platform stairs or a secondary one at a landing. In a circular staircase the newel may be a central upright post about which the steps wind. The newel post usually is placed on the floor, in which case it should be centered on the vertical center of the first riser. When the space at the bottom of a stairway is limited, the newel post is sometimes placed on the first, second, or third step. In this case the newel post is centered on the vertical center of the next riser.

Nosing

The rounded part of the tread of a stair that projects over the riser is called the nosing.

Riser

A riser is the vertical part of a step that covers the space between treads.

Step

A step consists of a riser and a tread.

Starting Step

The starting step is the first step in a set of stairs. In an open stairway it is usually different from the others. Three variations are shown in Fig. E-137.

Stringer

The inclined finish piece of a stairway to which the risers and treads are fitted is called a stringer. If The stringer is cut so that its top edge fits the outline shape of the risers and treads, it is called an "open" stringer. If the risers and treads are grooved into the stringer, so that a side view shows only the inclined stringer board and not the actual treads and risers, the stringer is called "closed" or "housed."

Tread

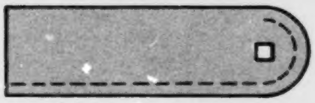
The horizontal part of a step is called the tread.

Wellhole

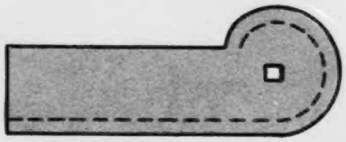
A wellhole is the framed hole in the floor through which a stairway passes or the open space in a building in which a staircase is built (also called "stairwell"). In a circular stairway it may be called the "cylinder." If the face stringers of two succeeding parallel flights of stairs are not located in the same vertical plane, the space between them is sometimes called the wellhole, but it is actually only a part.

Winders

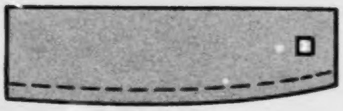
The treads of steps used where stairs are carried around curves or angles are called winders. Winders are wider at one end so that they can be arranged in a circular form.



BULLNOSE



CURTAIL



SWELLED OR CURVED

Fig. E-137. Three variations of starting steps

Layout Terminology

The construction of a wooden stairway is a complicated operation that is most often performed in a mill to dimensions specified by workers on the job. These dimensions are obtained by a careful layout procedure. If the stairs are concrete, with forms built by the cement mason, the dimensions used to build the forms will be provided by an equally detailed layout procedure. Any person who is to perform work on that stairway later must understand the terms used in its original layout. The basic dimensions must be checked and rechecked frequently because they cannot vary throughout the length of the stairway; all subsequent operations must be based on the same dimensions. Most of the dimensions described are illustrated in Fig. E-138.

Total Rise

The vertical distance from finish floor to finish floor is referred to as the total rise. This distance cannot be changed once a building has been constructed, and it is therefore a basic measurement to be kept in mind at all times.

Tread Rise

The vertical distance from the top of a tread to the top of the next is called the tread rise. All tread rises in a stairway must be the same because even a small variation is noticeable and may cause stumbling. Wooden risers come in sizes of 6½ to 7½ inches (16.5 to 19.1 centimetres), but the 7-inch (17.8-centimetre) riser is considered ideal for interior steps. Outside steps usually have a shorter rise.

Total Run

The overall horizontal distance occupied by a run of stairs is called the total run.

Tread Run

The tread run is the horizontal distance from the face of one riser to the face of the next. This does not include the nosing. In general, tread run plus tread rise should not exceed 17 inches (43.2 centimetres); a tread rise of 7 inches (17.8 centimetres) requires a tread run of no more than 10 inches (25.4 centimetres), excluding the nosing. Standard wooden treads are 10½ to 11½ inches (26.7 to 29.2 centimetres) wide, including the nosing.

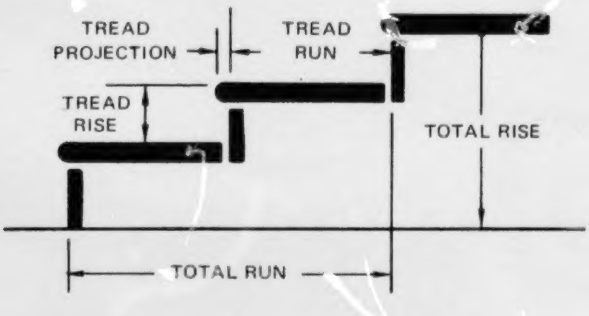


Fig. E-138. Layout terminology

Tread Projection or Overhang

The amount by which a tread projects over a riser is referred to as the tread projection or overhang. This amount is the width of the nosing.

Line of Travel

The line on a curved stairway connecting the points at which winders are of the same width as fliers is called the line of travel. This line usually is 12 to 14 inches (30.5 to 35.6 centimetres) from the handrail. The radii for laying out the winders are shifted so as to make the steps assume a reasonable shape and still maintain these dimensions (Figs. E-134 and E-135).

Tile Layout

A recommended procedure for laying out tile on a stairway is as follows:

1. Check plans carefully, noting the shape of the starting step and baluster pockets. If decorative tiles are to be used for risers, the order in which they are set and related details should be considered.
2. Determine the total rise and run of the stairs. These may be obtained from the plans, but the dimensions should be checked because the plans are seldom absolutely accurate.
3. When the total rise and run are known, determine the tread rise and tread run by dividing the total rise by the number of risers and the total run by the number of treads. A stairway always will have one more riser than it will have treads because the floor at the top of the stairway is not considered to be a tread. These dimensions will be important for you to know, as slight variations in the rough stairway should be compensated for when tile is placed.
4. Check the stairway to ensure that the stairs are correctly roughed in and that sufficient space has been allowed for the tiles. Note any variations from the correct tread run and rise, making sure they can be evened out in the process of applying the tile.
5. Make story poles 1 and 2 with the correct dimensions for the treads and risers (Fig. E-139). Mark off spaces with dividers.

The stairway can also be laid out for tiles by using a spirit level to mark lines along the wall for the finish faces of the treads and risers (Figs. E-140 through E-142). This procedure does not require story poles.

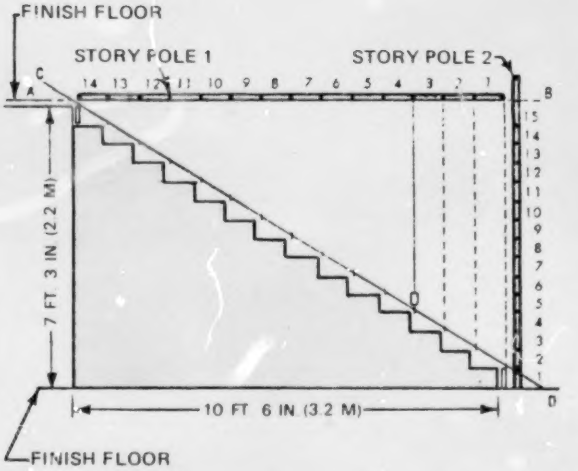


Fig. E-139. Tile stairway laid out with story poles 1 and 2

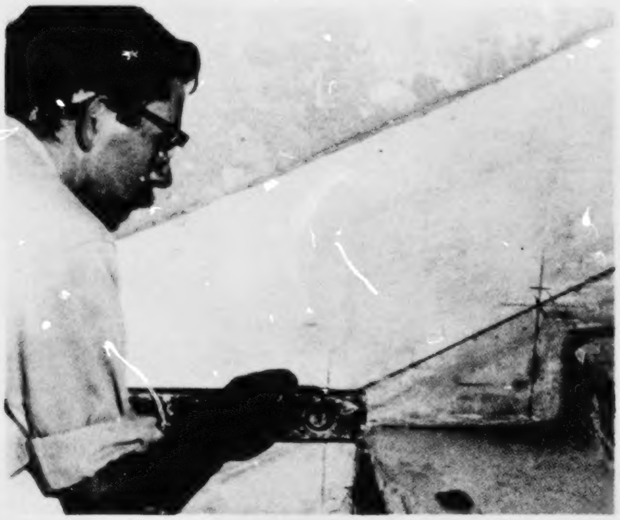


Fig. E-140. Marking with spirit level

Tile Installation

The recommended procedure for setting tile on a stairway by using story poles is as follows:

1. If the stairway is made of wood, cover it with waterproof paper. Apply a suitable wire mesh, followed by the scratch coat. If the stairs are concrete, follow a recommended preparation procedure.
2. As shown in Fig. E-139, draw line AB on the wall, at the level of the upper finish floor. Use story pole 2 to determine the correct height for point B, and check to ensure that the line is level.
3. Transfer the tread spacing from story pole 1 to line AB, allowing for the thickness of the setting bed and the tile in determining where to start the spacing.

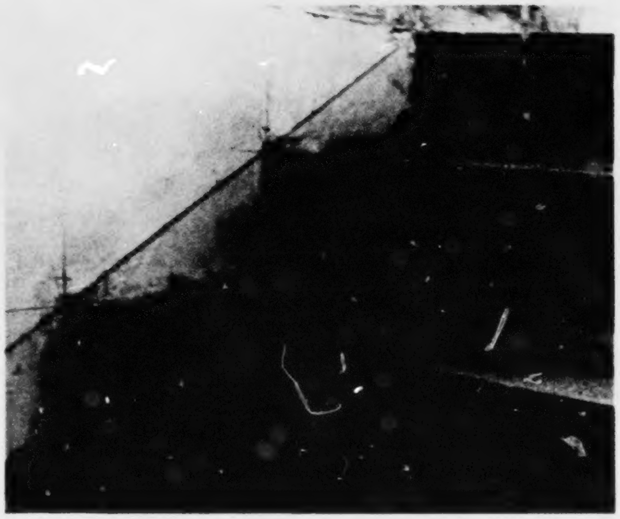


Fig. E-141. Quarry tile risers

Fig. E-142. Quarry tile risers and treads

4. Set the top and bottom risers, checking them with the marks on line AB. Use a tape or pole to see that the risers are parallel. Riser tiles may extend below the finish level of the treads, thus avoiding the need for cutting tiles to fit exactly.
5. With a taut chalk line, snap line CD from the top riser to the bottom riser.
6. Drop plumb lines from points representing tread runs on line AB to intersect line CD. These points of intersection represent the tops of the faces of the risers, both as to run and as to rise.
7. Set the tread nosing at the top, then the first tread, then the second riser, and continue down in this way to the bottom of the stairs. Check frequently to see that risers and treads are square

to the areas, level at the front and back of the treads, and parallel to each other.

8. Pitch treads ⅛ to ¼ inch (0.3 to 0.6 centimetre) high at the back for drainage and ease of cleaning. This is particularly important for an outside stairway, but it is usually done on other masonry steps as well. A tread should never be low at the back, because this gives a person ascending the stairs a feeling of running.
9. Use story pole 3, as shown in Fig. E-143, to make sure that all the joints are in a straight line from the top to the bottom of the stairs.

Some tilesetters set all the risers first and then return to set the treads. Whichever method is used, the work should always be started at the top of the stairs so that the tilesetter will not have to disturb fresh work.

A straightedge placed on the nosings of a stairway should touch each nosing from top to bottom of the stairway (Fig. E-143). This is the first test made by an inspector when a tile staircase is being checked.

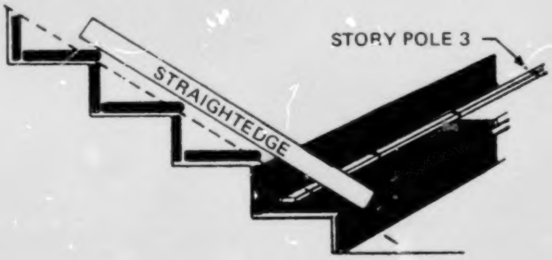


Fig. E-143. Tile stairway laid out with story pole 3

UNIT E — SPECIALIZED JOBS

TOPIC 15 — TILE STAIRS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The horizontal part of a step is called the 1 . — 1. ________

2. The riser is the 2 part of a step. — 2. ________

3. The distance from finish floor below to finish floor above is called 3 4 . — 3. ________ 4. ________

4. The line of travel on a curved stairway is set at 12 or 14 inches (30.5 or 35.6 centimetres) from the 5 . — 5. ________

5. When risers are parallel to each other, the steps are called 6 . — 6. ________

6. The function of the balusters is to support the 7 . — 7. ________

7. A(n) 8 9 may be used in place of a story pole to lay out steps. — 8. ________ 9. ________

8. A series of steps leading from one floor or landing to the next floor or landing, without an intervening platform, is called a(n) 10 stairway. — 10. ________

9. A level part of a staircase, which is wider than the individual steps, is called a(n) 11 or a(n) 12 . — 11. ________ 12. ________

10. Tread 13 is measured from the face of one riser to the face of the next. — 13. ________

11. The tread and riser taken together form a(n) 14 . — 14. ________

12. A term for a circular wellhole is a(n) 15 . — 15. ________

13. The curved projection of the tread over the riser is called the 16 . — 16. ________

14 One means of ensuring that tile on a stairway is set to exact dimensions is the use of three 17 18 . — 17. ________ 18. ________

15. A line along the wall parallel to the staircase is drawn from the 19 riser to the 20 riser. — 19. ________ 20. ________

TOPIC 16 — ROMAN TUBS

This topic is planned to provide answers to the following questions:

- **How is the basic structure prepared for a tile-lined bath?**
- **What is the recommended method of installing a Roman bath?**

The tilesetter will be called upon to lay tile for Roman tubs of every size and shape. Each tile-lined bath will provide the tilesetter with a new challenge. A Roman bath, such as the one shown in Fig. E-144, will require the layout skill of an experienced tilesetter.

Preparing the Structure

The tilesetter should check the waterproof membrane for damage if any work has been performed by others in and about the area. The membrane should be tested for leaks.

The slope in the floor of the structure should be adequate for correct drainage. Linings and reinforcing wire should be nailed or stapled above the water line.

Installing the Tile

All cement mortar used in the installation of a Roman bath must be mixed with an approved waterproofing admixture. Reinforcing wire should be placed in the approximate center of the mortar bed. The wire should extend up the side walls but in no case should it be less than 1 inch (2.5 centimetres) above the finished threshold. The corners at the dam should be lapped, and the reinforcing wire should extend over the threshold and ledges.

The total thickness of the floor mortar must not be less than 1¼ inches (3.2 centimetres) at any point. The tile floor should have a minimum pitch of ¼ inch (0.6 centimetre) per foot (30.5 centimetres) and a maximum pitch of ½ inch (1.3 centimetres) per foot (30.5 centimetres) toward the drain.

A ring of absorbent material must be placed around the weep holes to keep them open when the finishing materials are installed.

All corners must be rounded or at angles not in excess of 45 degrees. Grout is not acceptable for rounding the corners. Corners that meet the provisions of the Uniform Plumbing Code are illustrated in Fig. E-145.

Study Assignment

Standard Specification for the Installation of Tile-Lined Roman Bath Tubs (CTI-R4-108-64). Los Angeles: Ceramic Tile Institute. Read entire specification.

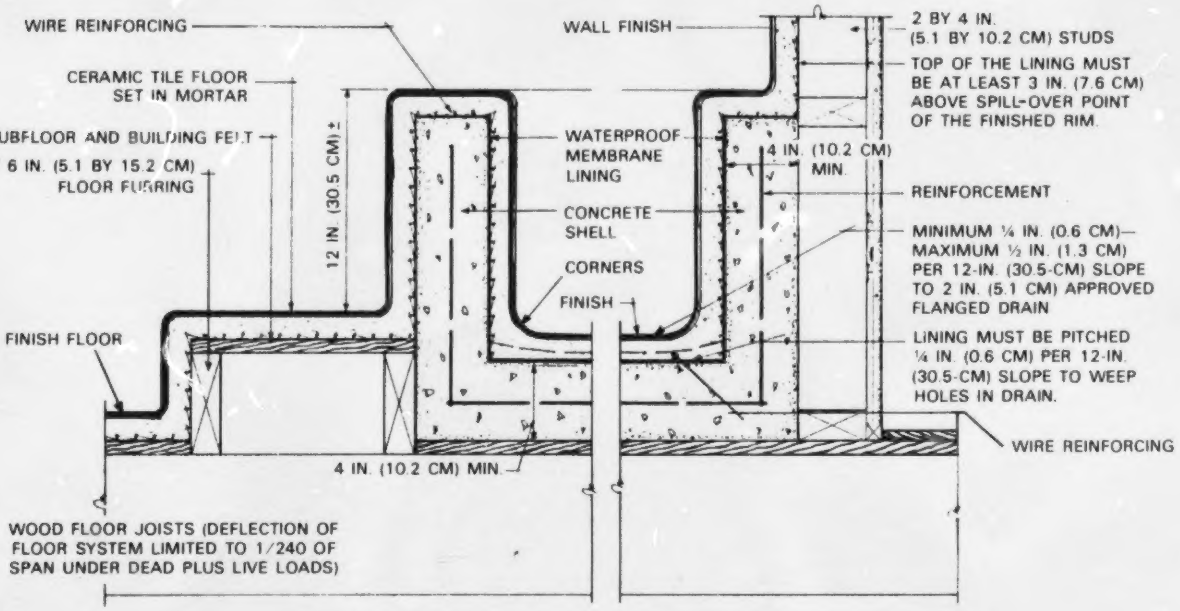

WIRE REINFORCING
CERAMIC TILE FLOOR SET IN MORTAR
SUBFLOOR AND BUILDING FELT
2 BY 6 IN. (5.1 BY 15.2 CM) FLOOR FURRING
12 IN. (30.5 CM) ±
FINISH FLOOR
4 IN. (10.2 CM) MIN.
WOOD FLOOR JOISTS (DEFLECTION OF FLOOR SYSTEM LIMITED TO 1/240 OF SPAN UNDER DEAD PLUS LIVE LOADS)
WALL FINISH
WATERPROOF MEMBRANE LINING
CONCRETE SHELL
CORNERS
FINISH
4 IN. (10.2 CM) MIN.
2 BY 4 IN. (5.1 BY 10.2 CM) STUDS
TOP OF THE LINING MUST BE AT LEAST 3 IN. (7.6 CM) ABOVE SPILL-OVER POINT OF THE FINISHED RIM.
REINFORCEMENT
MINIMUM ¼ IN. (0.6 CM)— MAXIMUM ½ IN. (1.3 CM) PER 12-IN. (30.5-CM) SLOPE TO 2 IN. (5.1 CM) APPROVED FLANGED DRAIN
LINING MUST BE PITCHED ¼ IN. (0.6 CM) PER 12-IN. (30.5-CM) SLOPE TO WEEP HOLES IN DRAIN.
WIRE REINFORCING

Fig. E-144. Construction of Roman bath

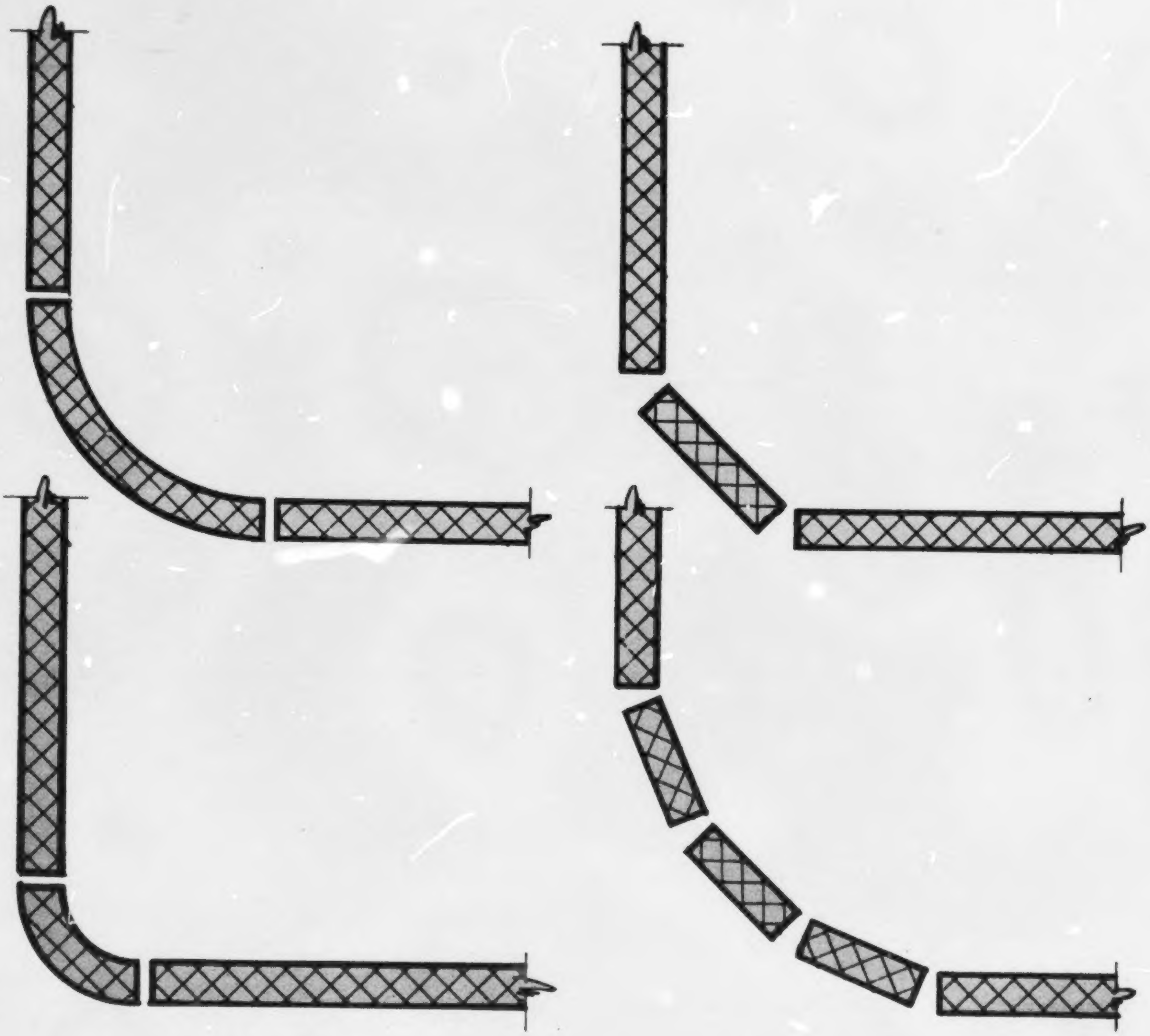


Fig. E-145. Approved corners for a tiled bath

UNIT E — SPECIALIZED JOBS

TOPIC 16 — ROMAN TUBS

Study Guide

Determine the correct word for each numbered blank in the sentence, and write it in the corresponding blank at the right.

1. The maximum pitch for a tub floor is _1_ inch(es) per foot toward the drain. 1. ________

2. A ring of _2_ material must be placed around the weep holes in the drain. 2. ________

3. The total thickness of the floor mortar must be not less than _3_ inch(es). 3. ________

4. Reinforcing wire should be nailed or stapled _4_ the waterline. 4. ________

5. The minimum pitch for a Roman tub floor is _5_ inch(es) per foot toward the drain. 5. ________

List of Acronyms

ACI	American Concrete Institute
AGA	American Gas Association
AGC	The Associated General Contractors of America
AIA	American Institute of Architects
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CSI	The Construction Specifications Institute
CTI	Ceramic Tile Institute
CTIOA	Ceramic Tile Institute of America
FTI	Facing Tile Institute
IUBAC	International Union of Bricklayers and Allied Craftsmen
MIA	Marble Institute of America
MMSA	Mortar Manufacturers Standards Association
NTMA	National Terrazzo and Mosaic Association, Inc.
PCA	Portland Cement Association
SCPI	Structural Clay Products Institute
TCA	Tile Council of America

Glossary

Effective communication among those who work in the tile trade is most important. Tilesetters must know the correct meaning of the words they use in their trade. This is particularly important in the construction industry where several trades may have different meanings for the same word.

Slang words that are used throughout the tile trade have been included in this Glossary. These words are most important for the apprentice tilesetter to understand. Slang words may vary from one geographical area to another, and instructors and students are urged to suggest additional terms through the channels available in their schools.

The origins of some of the definitions in the Glossary are indicated in parentheses following the definition. The designations used are as follows: ASTM (American Society for Testing and Materials); TCA (Tile Council of America); CTI (Ceramic Tile Institute); and SS-T-308b (*Federal Specifications for Ceramic Tile, Floor, Wall, and Trim Units*).

Absorption. The relationship of the weight of the water absorbed by a ceramic specimen subjected to prescribed immersion procedure to the weight of the dry specimen, expressed in percent. (ASTM C 242-72)

Accelerators. Materials used to speed up the setting of mortar.

Accessories (tile accessories). Ceramic or nonceramic articles, affixed to or inserted in tilework, as exemplified by towel bars; paper, soap, and tumbler holders; grab bars; and the like.

Acid- and alkali-resistant grout. A grout that resists the effects of prolonged contact with acids and alkalies.

Adhesive, tile. Organic adhesive used for bonding tile to a surface. Rubber solvents and resin-based and rubber emulsions can be used as adhesives. (TCA)

Alumina porcelain. A vitreous ceramic whiteware for technical application in which alumina (Al_2O_3) is the essential crystalline phase. (ASTM C 242-72)

Alumina whiteware. Any ceramic whiteware in which alumina (Al_2O_3) is the essential crystalline phase. (ASTM C 242-72)

Angle divider. A tool used by the tilesetter to determine the degree of an angle to cut. It is used for fitting trim, moldings, and flooring into corners. A corner angle is measured by adjusting the divider to fit the corner.

Backing. Any material used as a base over which a finished material is to be installed.

Backing off. See *Featheredging tile*.

Back-mounted tile. See under *Tile, mounted*.

Back wall. The wall facing an observer who is standing at the entrance to a room, shower, or tub shower.

Balanced cuts. Cuts of tile at the perimeter of an area that will not take full tiles. The cuts on opposite sides of such an area should be the same size. Also, the cuts on each side of a miter should be the same size.

Ball clay. A secondary clay, commonly characterized by the presence of organic matter, high plasticity, high dry strength, long vitrification range, and a light color when fired. (ASTM C 242-72)

Ball milling. A method of grinding and mixing material, with or without liquid, in a rotating cylinder or conical mill partially filled with grinding media, such as balls or pebbles. (ASTM C 242-72)

Basalt ware. A black unglazed vitreous ceramic ware that has the appearance of basalt rock. (ASTM C 242-72)

Base. One or more rows of tile installed above the floor. See *Cove*.

Basis for acceptance. The method of determining whether a lot of ceramic tile is acceptable under certain specifications.

Beating block. A wooden block used to embed tiles in a flat plane. The method used is called *beating in*.

Belleek china. A highly translucent whiteware composed of a body that contains a significant amount of frit and that normally has a luster glaze. It is produced commercially at Belleek, Ireland. (ASTM C 242-72)

Bench mark. Permanent reference point or mark.

Bisque fire. See *Fire, bisque*.

Blistering. The development during firing of enclosed or broken macroscopic vesicles or bubbles in a body, or in a glaze or other coating. (ASTM C 242-72)

Block angle. A square of tile specially made for changing direction of the trim.

Blunging. The wet process of blending or suspending ceramic material in liquid by agitation. (ASTM C 242-72)

Body. The structural portion of a ceramic article. This term also refers to the material or mixture from which the article is made. (ASTM C 242-56)

Bond. The adherence of one material to another. Effective bonds must be achieved between the mortar and scratch coat, between the tile and mortar, and between the adhesive and backing.

Bond coat. A material used between the back of the tile and the prepared surface. Suitable bond coats include pure portland cement, Dry-set portland cement mortar, latex-type portland cement mortar, organic adhesive, and the like.

Bone ash. Calcined bone that consists essentially of calcium phosphate. (ASTM C 242-72)

Bone china. A translucent china made from a ceramic whiteware body composition containing a minimum of 25 percent bone ash. (ASTM C 242-72)

Brick trowel. A trowel that is larger than the buttering trowel. The most popular size used by tilesetters is 5 inches (12.7 centimetres) wide and 11 inches (27.9 centimetres) long. It is used when any preparatory brick work has to be done. Some tilesetters use it for quarry and terra cotta tilework. Its greater surface and weight are advantageous in the buttering and tapping in of the larger tiles.

Bridge. A straightedge used as a starting line for the laying of tile. The straightedge can be blocked up to support tile over an opening.

Bright glaze. A colorless or colored ceramic glaze having high gloss. (ASTM C 242-72)

Bullnose. A trim tile with a convex radius on one edge. This tile is used for finishing the top of a wainscot or for turning an outside corner.

Bullnose corner. A type of bullnose trim with a convex radius on two adjacent edges.

Bushhammer. A hammer that has a rectangular head with serrated or jagged faces. The bushhammer is used for roughing concrete to provide a bond for masonry.

Butterfly. A slang term for inside corner angles for trim shapes such as AB 106, AF 105, AF 200, AK 106, and AU 106.

Buttering. The spreading of a bond coat (followed by a mortar coat, a thin-setting bed mortar, or an organic adhesive) to the backs of ceramic tile just before the tile is placed.

Buttering trowel. A trowel that has a blade 4½ inches (11.4 centimetres) wide and 7 inches (17.8 centimetres) long. It is used in buttering pure cement to tile, a method commonly used in the eastern states. This trowel is more efficient than the pointer for working on the larger and heavier tiles because more weight can be placed on it.

Calcine. A ceramic material or mixture fired to less than fusion for use as a constituent in a ceramic composition. (ASTM C 242-72)

Cap. See *Bullnose*

Casting. Forming ceramic ware by introducing a body slip into a porous mold which absorbs sufficient water from the slip to produce a semirigid article. (ASTM C 242-72)

Casting, drain (hollow casting). Forming ceramic ware by introducing a body slip into an open porous mold, and then draining off the remaining slip when the cast has reached the desired thickness. (ASTM C 242-72)

Casting plaster. A fast-setting gypsum plaster that is used to anchor marble to walls, set spots, or mix temporary "hot mud."

Casting, solid. Forming ceramic ware by introducing a body slip into a porous mold that usually consists of two major sections, one section forming the contour of the outside and the other forming the contour of the inside of the ware and allowing a solid cast to form between the two mold faces. (ASTM C 242-72)

Caulking compound. Waterproof caulking material usually sold in tubes. See also *Sealant.*

Ceiling mortar. Extra-rich wall mortar.

Cement body tiles. Tiles with the body made from a mixture of portland cement and sand. The surface may be finished with portland cement, spheroids of marble, or other materials.

Cement grout. A cementitious mixture of portland cement, sand or other ingredients, and water. The mix produces a water-resistant, uniformly colored material used to fill joints between tile units.

Cement mortar. A cementitious mixture of portland cement, sand or other ingredients, and water. This mortar is used for bonding tile to backup material.

Ceramic article. An article having a glazed or unglazed body of crystalline or partly crystalline structure, or of glass. The body is produced from essentially inorganic, nonmetallic substances and is formed either from a molten mass which solidifies on cooling or is formed and simultaneously or subsequently matured by the effects of the heat. (ASTM C 242-72)

Ceramic mosaic tile. An unglazed tile formed by either the dust-pressed or plastic method, usually ¼ to ⅜ inch (0.6 to 1.0 centimetre) thick. It has a facial area of less than 6 square inches (38.7 square centimetres) and is usually mounted on sheets approximately 1 by 2 feet (30 by 61 centimetres) to facilitate setting. Ceramic mosaic tile may be of either porcelain or natural clay composition. It may be plain, or it may have an abrasive mixture throughout. (ASTM C 242-72)

Ceramic process. The production of articles or coatings from essentially inorganic, nonmetallic materials. The article or coating is made permanent and suitable for utilitarian and decorative purposes by the action of heat at temperatures sufficient to cause sintering, solid-state reactions, bonding, or conversion partially or wholly to the glassy state. (ASTM C 242-72)

Ceramic tile. A ceramic surfacing unit, usually relatively thin in relation to facial area, made from clay or a mixture of clay and other ceramic material, called the body of the tile. The tile has either a glazed or unglazed face. It is fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics.

Ceramic whiteware. A fired ware that consists of a glazed or unglazed ceramic body which is commonly white and of fine texture. This term designates such products as china, porcelain, semivitreous ware, and earthenware. (ASTM C 242-72)

Ceramics. A general term applied to the art or technique of producing articles by a ceramic process, or to the articles so produced. (ASTM C 242-72)

Chalk line. Usually cotton cord coated with chalk. The cord is snapped to mark a straight line. The chalk line is used to align spots or screeds.

Chemical porcelain. Vitreous ceramic whiteware used for holding, transporting, or mixing chemicals. (ASTM C 242-72)

China. A glazed or unglazed vitreous ceramic whiteware used for nontechnical purposes. This term designates such products as dinnerware, sanitary ware, and art ware when they are vitreous. See also *Bone china.* (ASTM C 242-72)

China process. The method of producing glazed ware by which the ceramic body is fired to maturity, following which the glaze is applied and matured by firing at a lower temperature. (ASTM C 242-72)

China sanitary ware (sanitary plumbing fixtures). Glazed, vitrified whiteware fixtures having a sanitary service function. (ASTM C 242-72)

Chipping hammer. A lightweight hammer that comes in a variety of sizes. The head and back can be capped with tungsten carbide for durability. It is used by the tilesetter to chip excessive material from the backs and edges of wall and quarry tiles, thus reducing the amount of grinding work necessary to smooth a cut.

Clay. A natural mineral aggregate, consisting essentially of hydrous aluminum silicates. It is plastic when sufficiently wetted, rigid when dried as a whole, and vitrified when fired to a sufficiently high temperature. (ASTM C 242-72)

Clear glaze. A colorless or colored transparent ceramic glaze. (ASTM C 242-72)

Cleavage membrane. A layer of 15-pound (7-kilogram) roofing felt or an equivalent type of construction paper or polyethylene sheeting. It is used to isolate a wire-reinforced mortar bed from the concrete substrate. (CTI)

Cold joint. Any point in a tile installation where tile and setting bed have terminated and the surface has lost its plasticity before work is continued.

Colored grout. Commercially prepared grout consisting of carefully graded aggregate, portland cement, water-dispersing agents, plasticizers, and color-fast pigments. (CTI)

Composition tile. A hard tile surfacing unit made from a mixture of chemicals. The finished surface can be the mixture of chemicals or can be marble chips to create a terrazzo finish. The unit is made hard by the set of the chemicals. The tile is not fired as in the manufacture of ceramic tile. (CTI)

Conductive mortar. A tile mortar to which specific electrical conductivity is imparted through the use of conductive additives. (TCA)

Conductive tile. Tile made from special body compositions or by methods that result in specific properties of electrical conductivity while retaining other normal physical properties of ceramic tile. (SS-T-308b)

Contaminated. Tile stained as a result of carton and tile being saturated by moisture, oils, solvents, or other materials.

Control joints. See *Expansion joint.*

Conventional installation. The method of installing ceramic tile with portland cement mortar.

Cordierite porcelain. A vitreous ceramic whiteware for technical application in which cordierite ($2MgO \cdot 2Al_2O_3$ $5SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Cordierite whiteware. Any ceramic whiteware in which cordierite ($2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Cove. A trim tile unit having one edge with a concave radius. A cove is used to form a junction between the bottom wall course and the floor or to form an inside corner. (TCA)

Cove base (sanitary). A trim tile having a concave radius on one edge and a convex radius with a flat landing on the opposite edge. This base often is used as the only course of tile above the floor tile.

Covering power. The ability of a glaze to uniformly and completely cover the surface of the fired water. (ASTM C 242-72)

Cracked tiles. Tiles that have been cracked into one or more pieces usually during the beating-in process of installation. These will show up as hairline cracks.

Crawling. A parting and contraction of the glaze on the surface of ceramic ware during drying or firing, resulting in unglazed areas bordered by coalesced glaze. (ASTM C 242-58T)

Crazing. The cracking that occurs in fired glazes or other ceramic coatings due to critical tensile stresses. (ASTM C 242-72)

Crow hop. A slang term used to describe tile joints that are out of alignment.

Crystalline glaze. Glazed tile with an extra heavy glaze produced for use on counter tops and light-duty floor surfaces where abrasion or impact is not excessive. (CTI)

Cushion-edged tile. Tile on which the facial edges have a distinct curvature that results in a slightly recessed joint.

Dago float. A slang term used to describe the use of a fresh mortar screed in lieu of float strips to rod floor mortar. This method is commonly used in floor work. Italian terrazzo workers use this technique to align "concrete" for placement of brass or aluminum strips to the desired grade.

Dago stick. A slang term used by tilesetters when referring to a small piece of wood used to rod off mortar that has been applied to fill the holes caused by the removal of float strips.

Deck or floor mortar. Mortar commonly used for decks or floors. It consists of sand and regular portland cement mixed with water to a firm consistency.

Decorated. Adorned, embellished, or made more attractive by means of color or surface detail. (ASTM C 242-72)

Decorating fire. See *Fire, decorating.*

Decoration, inglaze. A ceramic decoration applied on the surface of an unfired glaze and matured with the glaze. (ASTM C 242-72)

Decoration, overglaze. A ceramic or metallic decoration applied and fired on the previously glazed surface of ceramic ware. (ASTM C 242-72)

Decoration, underglaze. A ceramic decoration applied directly on the surface of ceramic ware and subsequently covered with a transparent glaze. (ASTM C 242-72)

Decorative tile. Tile with a ceramic decoration on the surface. (See headings under *Decoration.*)

Deformation eutectic. See *Eutectic, deformation.*

Delft ware. A calcareous earthenware having an opaque white glaze and monochrome overglaze decorations. (It was produced originally in Delft, Holland.) (ASTM C 242-72)

Dolomite. The double carbonate of lime and magnesia having the general formula $CaCO_3 \cdot MgCA_3$. (ASTM C 242-72)

Dope coat. Neat cement applied to the setting bed.

Double bullnose. A type of trim with the same convex radius on two opposite sides.

Drain casting. See *Casting, drain.*

Dry edging. Rough edges and corners of glazed ceramic ware due to insufficient glaze coating. (ASTM C 242-72)

Dry mix. See *Process, dry.*

Dry pressing. See *Pressing, dry.*

Dry process. See *Process, dry.*

Drying. Removal, by evaporation, of uncombined water or other volatile substances from a ceramic raw material or product. The process can be expedited by heating at low temperatures. (ASTM C 242-72)

Dry-set mortar. A water-retentive hydraulic cement mortar usable with or without sand. When this mortar is used, neither the tile nor walls have to be soaked during the installation process.

Dunting. The cracking that occurs in fired ceramic bodies as a result of thermally induced stresses. (ASTM C 242-72)

Dusting. The application of dry portland cement to a wet floor or deck mortar surface. A pure coat is thus formed by suction of the dry cement.

Dutchman. A cut tile used as a filler in the run of a wall or floor area.

Dynamite. A slang term used by tilesetters when referring to a mortar accelerator.

Eagle beak. A 6 by ¾ inch (15.2 by 1.9 centimetre) outside corner trim shape.

Earthenware. A glazed or unglazed nonvitreous ceramic whiteware. (ASTM C 242-72)

Edge-bonded tile. See *Pregrouted tile.*

Edge-mounted tile. Tiles assembled into units or sheets and bonded to each other at the edges or corners of the back of the tiles by an elastomeric or resinous material which becomes an integral part of the tile installation. Units or sheets must meet criteria of back-mounted sheets. See *Mounted tile.*

Efflorescence. The residue deposited on the surface of a material by the crystallization of soluble salts.

Eggshell. The texture of a fire glaze similar in appearance to the surface of an eggshell. (ASTM C 242-72)

Electrical porcelain. Vitrified whiteware having an electrical insulating function. (ASTM C 242-72)

Embossed. Decorated in relief on the surface of the ware. (ASTM C 242-72)

Engobe. A slip coating applied to a ceramic body for imparting color, opacity, or other characteristics. It subsequently is covered with a glaze. (ASTM C 242-72)

Epoxy adhesive. A two-part adhesive system employing epoxy resin and epoxy hardener. It is used for bonding of ceramic tile to backup materials.

Epoxy grout. A two-part grout system consisting of epoxy resin and epoxy hardener, specially formulated to have impervious qualities, stain, and chemical resistance. It is used to fill joints between tile units.

Epoxy mortar. A two-part mortar system consisting of epoxy resin and epoxy hardener. It is used to bond tile to backup material where chemical resistance of high bond strength is a consideration.

Epoxy resin. An epoxy composition used as a chemical-resistant setting adhesive or chemical-resistant grout.

Equilibrium eutectic. See *Eutectic, equilibrium.*

Eutectic, deformation. A composition within a system of two or more components. When heated under specified conditions, the composition develops sufficient liquid to cause deformation at the lowest temperature possible. (ASTM C 242-72)

Eutectic, equilibrium (eutectic). A composition within any system of two or more crystalline phases. The composition melts completely at the lowest temperature possible. (ASTM C 242-72)

Expansion joint. A joint through the tile, mortar, and reinforcing wire down to the substrate.

Extra-duty tile. See *Special-purpose tile.*

Extruded tile. A tile or trim unit that is formed when plastic clay mixtures are forced through a pug mill opening (die) of suitable configuration, resulting in a continuous ribbon of formed clay. A wire cutter or similar device is then used to cut the ribbon into appropriate lengths and widths of tile. (TCA)

Face-mounted tile. See *Tile, mounted.*

Facial defect. That portion of the facial surface of the tile which is readily observed to be nonconforming and which detracts from the aesthetic appearance or serviceability of the installed tile.

Faience mosaics. Faience tiles that are less than 6 square inches (39 square centimetres) in facial area, usually $\frac{5}{16}$ to $\frac{3}{8}$ inch (0.8 to 1 centimetre) thick and mounted to facilitate installation. (ASTM C 242-72)

Faience tiles. Glazed or unglazed tiles, generally made by the plastic process, showing characteristic variations in the face, edges, and glaze. These variations produce a handcrafted, nonmechanical, decorative effect. The tiles range in size from 6 by 6 inches (15.2 by 15.2 centimetres) to 12 by 12 inches (30.5 by 30.5 centimetres). (ASTM C 242-72)

Faience ware. Formerly, a decorated earthenware with an opaque glaze. This term now designates decorated earthenware with a transparent glaze. (ASTM C 242-72)

Fan or fanning. Spacing tile joints to widen certain areas so they will conform to a section that is not parallel.

Featheredging tile (mitering). The method of chipping away the body from beneath a facial edge of a tile in order to form a miter.

Feature strip (decorated liner). A narrow strip of tile that has a contrasting color, texture, or design.

Feldspar. A mineral aggregate consisting chiefly of microcline, albite, and anorthite. (ASTM C 242-72)

Field tile. An area of tile covering a wall or floor. The field is bordered by tile trim.

Fifty-fifty. See *Spacing mix.*

Filler. See *Spacing mix.*

Fire, bisque. The process of kiln-firing ceramic ware prior to glazing. (ASTM C 242-72)

Fire, decorating. The process of firing ceramic or metallic decorations on the surface of glazed ceramic ware. (ASTM C 242-72)

Fire, glost. The process of kiln-firing bisque ware to which glaze has been applied. (ASTM C 242-72)

Fire, single. The process of maturing an unfired ceramic body and its glaze in one firing operation. (ASTM C 242-72)

Firing. The controlled heat treatment of ceramic ware in a kiln or furnace, during the process of manufacture, to develop the desired properties. (ASTM C 242-72)

Firing range. The range of firing temperatures within which a ceramic composition develops properties which render it commercially useful. (ASTM C 242-72)

Flakes. Irregularities left on the edge of the tile mainly due to the use of machine cutting tools. Such tile is described as flaked.

Flat trowel. A trowel used in conjunction with the hawk for the transferring of mortar from the mortarboard to the wall or to other vertical surfaces. It is frequently used for spreading pure cement on the finished float coat. The flat trowel also is used for spreading mortar on floor surfaces before tiles are set.

Float coat. The final mortar coat over which the neat coat, pure coat, or skim coat is applied.

Float strip. A strip of wood about ¼ inch (0.6 centimetre) thick and 1¼ inches (3.2 centimetres) wide. It is used as a guide to align mortar surfaces.

Floating. A method of using a straightedge to align mortar with the float strips or screeds. This technique also is called *dragging, pulling, rodding,* or *rodding off.*

Flux. A substance that promotes fusion in a given ceramic mixture. (ASTM C 242-72)

Forming. The shaping or molding of ceramic ware. (ASTM C 242-72)

Forsterite porcelain. A vitreous ceramic whiteware for technical application in which forsterite ($2MgO \cdot SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Forsterite whiteware. Any ceramic whiteware in which forsterite ($2MgO \cdot SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Freehand floating. The application of wall mortar without the use of guide screeds. This technique is used by specialists when they are setting glass mosaic murals.

Frit. A glass which contains fluxing material and is employed as a constituent in a glaze, body, or other ceramic composition. (ASTM C 242-72)

Fritted glaze. A glaze in which a part or all of the fluxing constituents are prefused. (ASTM C 242-72)

Frostproof tile. Tile produced for use where freezing and thawing conditions occur. (CTI)

Furan mortar. A two-part mortar system of furan resin and furan hardener used for bonding tile to backup material where chemical resistance of floors is important.

Furan resin. A furan resin composition used as a chemical-resistant setting adhesive or chemical-resistant grout.

Furan resin grout. A two-part grout system of furan resin and furan hardener used for filling joints between quarry tile and pavers where chemical-resistant properties are required.

Furring. Stripping used to build out a surface, such as a studded wall where strips of suitable size are added to the studs to accommodate vent pipes or other fixtures. (TCA)

Fusion. The process of melting; usually the result of interaction of two or more materials. (ASTM C 242-72)

Gauging trowel. A trowel that is larger than the pointing trowel but smaller than the buttering trowel. Tilesetters prefer the 3¼ by 7 inch (8.2 by 17.8 centimetre) size.

Glass mosaic tiles. Tiles made of glass, usually in sizes not over 2 inches (5.1 centimetres) square and ¼ inch (0.6 centimetre) thick, mounted on sheets of paper. The sheets usually are 12 inches (30.5 centimetres) square.

Glaze. A ceramic coating matured to the glassy state on a formed ceramic article. The term glaze also refers to the material or mixture from which the coating is made.

Bright glaze. A high-gloss coating with or without color. (ASTM C 242-56)

Clear glaze. A transparent glaze with or without color. (ASTM C 242-56)

Crystalline glaze. A glaze that contains microscopic crystals. (ASTM C 242-56)

Fritted glaze. A glaze in which a part or all of the fluxing constituents are prefused. (ASTM C 242-56)

Mat glaze. A low-gloss ceramic glaze with or without color. (ASTM C 242-56)

Opaque glaze. A nontransparent glaze with or without color. (ASTM C 242-56)

Raw glaze. A glaze compounded primarily from raw constituents. It contains no prefused materials. (ASTM C 242-56)

Semimat glaze. A medium-gloss ceramic glaze with or without color. (ASTM C 242-56)

Speckled glaze. A glaze containing granules of oxides or ceramic stains that are of contrasting colors. (TCA)

Glaze fit. The stress relationship between the glaze and body of a fired ceramic product. (ASTM C 242-72)

Glazed ceramic mosaic tile. Ceramic mosaic tile with glazed faces. (ASTM C 242-72)

Glazed interior tile. A glazed tile with a body that is suitable for interior use and which is usually nonvitreous, and is not required or expected to withstand excessive impact or be subject to freezing and thawing conditions. (ASTM C 242-72)

Glazed paver tile. See *Paver tile.*

Glazed quarry tile. See *Quarry tile.*

Glazed tile. Tile with a fused impervious facial finish composed of ceramic materials, fused into the body of the tile. The body may be nonvitreous, semivitreous, vitreous, or impervious. The glazed surface may be clear, white, or colored. (ASTM C 242-72)

Glazed tile, extra-duty glaze. Tile with a durable glaze that is suitable for light-duty floors and all other surfaces on interiors where no excessive abrasion or impact occurs. (ASTM C 242-72)

Glost fire. See *Fire, glost.*

Grade. A predetermined degree of slope that a finished floor should have.

Grout. A rich or strong cementitious or chemically setting mix used for filling tile joints. (TCA)

Grout, colored. See *Colored grout.*

Grout saw. A saw-toothed carbide steel blade mounted on a wooden handle. It is used to remove old grout. It also is used in patching work. Care should be taken to prevent damage to adjacent tiles. The carbide steel blade is brittle, and it will shatter if it is dropped or abused. On the front of the saw blade is a spring steel tip. This is used for scraping grout out of corners where the saw blade cannot reach.

Grouting. The process of filling the tile joints with grout. (TCA)

Half and half. See *Spacing mix.*

Hard screed. A mortar screed that has become firm.

Hard tile. Any of the tile products under the jurisdiction of tile layers. Such products do not include resilient tile, which is not under the jurisdiction of tile layers. (CTI)

Hawk. Device used for carrying mortar. Hawks range in size from 10 to 14 inches (25.4 to 35.6 centimetres) square, but tilesetters generally prefer the 11-inch (27.9-centimetre) square. Most hawks are made of aluminum with a wooden handle at the center. A rubber pad fits over the handle and covers that portion of the metal hawk that would come in contact with the hand. The hawk should not be held with a hand that is wet or covered with lime or mortar.

Healing power. The ability of a glaze to heal surface blemishes during firing. (ASTM C 242-72)

Heavy-duty tile. Tile suitable for areas of heavy pedestrian traffic. Tile can be specified to meet higher test values as determined by job requirements, but a minimum heavy-duty tile test requirement is necessary.

Hollow casting. See *Casting, drain.*

Hopped-up mud. Mortar mixed with an acclerator.

Horizontal broken joints. A style of laying tile with each course offset one-half its length.

Hot mud or hot stuff. Mortar mixed with an accelerator.

Hot pressing. See *Pressing, hot.*

Impervious. That degree of vitrification evidenced visually by complete resistance to dye penetration. (ASTM C 242-72)

NOTE: The term impervious generally signifies zero absorption, except for floor and wall tile, which are considered "impervious" up to 0.5 percent water absorption.

Incised. Decorated by cutting or indenting the ware surface. (ASTM C 242-72)

Inglaze decoration. See *Decoration, inglaze.*

Ironstone ware. (Stone china, white granite ware). Historic terms for a durable English earthenware. (ASTM C 242-72)

Jagged edges. Irregularities left on the edges of the tile when hand cutting tools are used.

Jasperware. A vitreous, opaque, colored unglazed ceramic ware having white or contrasting relief decorations and containing a substantial amount of barite. Originally developed by Josiah Wedgwood. (ASTM C 242-72)

Jiggering. Forming ceramic ware from a plastic body by differential rotation of a profile tool and mold, the mold having the contour of one surface of the ware and the profile tool that of the other surface. (ASTM C 242-72)

Kaolin (china clay). A refractory clay that consists essentially of minerals of the kaolin group and that fires to a white or nearly white color. (ASTM C 242-72)

Knockings. The oversize residue obtained in the screening of a ceramic slip. (ASTM C 242-72)

L cut. A piece of tile cut or shaped to the letter L.

Latex-portland cement grout. A portland cement grout with a special latex additive which results in a less rigid, less permeable grout than regular portland cement grout.

Latex-portland cement mortar. A mixture of portland cement, sand, and special latex additives. This mortar is used for bonding tile to backup material. It is less rigid than portland cement mortar.

Lath. A wood strip or metal mesh, which acts as a background or reinforcing agent for the scratch coat or mortar coat. (TCA)

Layout stick. A long strip of wood marked at the appropriate joint intervals for the tile to be used. It is used to check the length, width, or height of the tilework. A common name for this item is *idiot stick.*

Leg. A tile wall running alongside a bathtub or abutment. This term sometimes is used to describe a narrow strip of tile floor.

Leveling coat. See *Plumb scratch.*

Light-duty tile. Tile suitable for areas of limited pedestrian traffic; e.g., entryways in single family residences.

Lugs. See *Self-spacing tile.*

Majolica. Formerly an earthenware with an opaque luster glaze and overglaze colored decorations, but currently designating any decorated earthenware with an opaque glaze. (ASTM C 242-72)

Marble mosaic tile. Tile made of small marble tesserae that vary slightly in size, usually about ½ inch (1.3 centimetres) square and mounted on sheets of paper to facilitate installation. (CTI)

Marble tiles. Marble cut into tile sizes 12 inches (30.5 centimetres) square or less, usually ½ to ¾ inch (1.3 to 1.9 centimetres) thick. The finishes may be polished, honed, split-faced, and so forth.

Masking power. The ability of a fired glaze to mask visually the body on which it is applied. (ASTM C 242-72)

Master grade certificate. A certificate that states that the tiles listed in the shipment and described on the certificate are made in accordance with TCA 137.1-76.

Mastic. Organic tile adhesive.

Mastic grout. A chemical mixture of organic and inorganic ingredients forming a one-part grouting composition that is used directly from the manufacturer's container. This grout is more flexible and stain resistant than cement grout.

Mat glaze. A colorless or colored ceramic glaze having low gloss. (ASTM C 242-72)

Maturing range. The time-temperature range within which a ceramic body, glaze, or other composition may be fired to yield specified properties. (ASTM C 242-72)

Medium-duty tile. Tile suitable for areas of medium pedestrian traffic; e.g., entryways in multiple dwellings.

Melt. To change a solid into a liquid by the application of heat; or the liquid that results from such action. (ASTM C 242-72)

Metal quarry tile rack. Metal pattern used in tile layout. The rack is used to maintain the correct width between quarry tiles. They can be made to order for special patterns.

Mexican paver tiles. Terra cotta-like tiles that are used mainly for floors. These handmade tiles vary in color, texture, and appearance from tile to tile. They are available in squares up to 12 inches (30.5 centimetres), hexagons, octagons, and other shapes. These tiles are coated with various types of sealers because of their soft absorptive characteristics. The sealers protect the surface against wear. (CTI)

Moisture expansion. An increase in the dimension or bulk volume of a ceramic article caused by reaction with water or water vapor. (ASTM C 242-72)

NOTE: This reaction may occur in time at atmospheric temperature and pressure. The reaction is expedited by exposure of the article to water or water vapor at elevated temperatures and pressures.

Monochrome decoration. A single color decoration. (ASTM C 242-72)

Mortarboard. A board used as a table to hold mortar. It is usually 30 inches (76.2 centimetres) square.

Mortar hoe. A hoe used for hand-mixing mortar. The best type has a perforated blade and a handle about 66 inches (165 centimetres) in length. The hoe should be kept clean and free of all mortar so it can be pushed and pulled easily through a box of mortar.

Mortar mixer. A mixer that is driven by gasoline combustion engines of 1½ horsepower or greater, depending on the type of sack mix. Electrically driven mixers are used when small batches of mortar are needed. The quality of machine-mixed mortar far exceeds that of hand-mixed mortar.

Mortar pumping machine. A mortar pumping machine used with the mortar mixer. Mixed mortar is poured into the hopper, and a pneumatic gun forces the mortar through a hose. The mortar can be delivered through the hose to tilesetters working as high as 13 stories above the street. Asbestos fines are added to the mortar as a bonder so that the mortar in the hose will not separate. The plastering gun can be used on the hose, and the hose can be used as a hoist.

Mosaics. Small tiles or bits of tile, stone, or glass. The materials can be used to form a surface design or an intricate pattern.

Mounted tile. Tile assembled into units or sheets by suitable material to facilitate handling and installation. Tile may be face-mounted, back-mounted, or edge-mounted. Face-mounted tile assemblies may have paper or other suitable material applied to the face of each tile, usually by water-soluble adhesives so that the paper can easily be removed after installation but prior to grouting of the joints. Back-mounted tile assemblies may have perforated paper, fiber mesh, resin, or other suitable material bonded to the back or edges of each tile. Back-mounted and edge-mounted tile assemblies must have a sufficient exposure of tile and joints surrounding each tile to comply with bond strength requirements. Tile manufacturers must specify whether back-mounted and edge-mounted tile assemblies are suitable for installation in swimming pools, on exteriors, or in wet areas.

Mud. A slang term for mortar.

Mullite porcelain. A vitreous ceramic whiteware for technical application in which mullite ($3Al_2O_3 \cdot 2SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Mullite whiteware. Any ceramic whiteware in which mullite ($3Al_2O_3 \cdot 2SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Murals. Tile installed in a precise area of a wall or floor to provide a decorative design or picture. Glass or marble mosaic tiles (tesserae) are made to form a picture or design. Ceramic tiles are painted and fired to form a picture or design. See *Decorated* and *Decoration.*

Natural clay tile. A tile made by either the dust-pressed method or the plastic method, from clays that produce a dense body having a distinctive, slightly textured appearance. (ASTM C 242-72)

Neat cement. Portland cement mixed with water to a desired creamy consistency.

Nepheline syenite. A mineral aggregate consisting chiefly of albite, microcline, and nephelite. (ASTM C 242-72)

Nominal sizes. The approximate facial size or thickness of tile, expressed in inches or fractions of an inch, for general reference.

Nonslip tile. Tile having greater nonslip characteristics due to an abrasive admixture, abrasive particles in the surface, grooves or patterns in the surface, or natural nonskid surface characteristics.

Nonvitreous (nonvitrified). That degree of vitrification evidenced by relatively high water absorption. (ASTM C 242-72)

NOTE: The term nonvitreous generally signifies more than 10 percent water absorption, except for floor and wall tiles, which are considered nonvitreous when water absorption exceeds 7 percent.

Notched trowels. Trowels used to apply all of the various kinds of bonding materials for ceramic tile. They are available in the serrated and square-tooth design. The teeth are made in various sizes. The correct tooth size and depth must be used to apply the thickness of bonding mortar specified. When the teeth become worn, the trowel has to be resharpened or replaced.

Opaque glaze. A nontransparent colored or colorless glaze. (ASTM C 242-72)

Open time. The period of time during which the bond coat retains its ability to adhere to the tile and bond the tile to the substrate.

Orangepeel. A pitted texture of a fired glaze resembling the surface of rough orange peel. (ASTM C 242-72)

Organic adhesive. A prepared organic material, ready to use with no further addition of liquid or powder, used for bonding tile to backup material by the thin-set method. The material cures or sets by evaporation.

Oven ware. Ceramic whiteware for culinary oven use. (ASTM C 242-72)

Overglaze decoration. See *Decoration, overglaze.*

Paper and wire. Tar paper and wire mesh (or metal lath) that are used as a backing for the installation of tile.

Paper-mounted ceramic mosaics. Ceramic mosaic tiles mounted on paper. Paper is applied to face of tile in sheets approximately 12 inches (30 centimetres) wide and 24 inches (61 centimetres) long.

Pate dure (hard paste). A French term designating ceramic whiteware fired at relatively high temperatures. (ASTM C 242-72)

Pate tendre (soft paste). A French term designating ceramic whiteware fired at relatively low temperatures. (ASTM C 242-72)

Paver tile. Unglazed porcelain or natural clay tile formed by the dust-pressed method and similar to ceramic mosaics in composition and physical properties but relatively thicker with 6 square inches (38.7 square centimetres) or more of facial area. (ASTM C 242-72)

Peeling. See *Orangepeel* and *Shivering.*

Pencil rod. Reinforcing steel rod with a diameter of ¼ inch (0.6 centimetre).

Physical properties of ceramic tile. Those properties as measured by ASTM tests.

Pinholes. Imperfections in the surface of a ceramic body or glaze resembling pin pricks. (ASTM C 242-72)

Pitted. Indentations in the finished surface of individual tiles other than at the corners and edges. The indentations are caused by sharp corners on trowels and other tools.

Plastic pressing. See *Pressing, wet.*

Plumb. Perpendicular to a true level.

Plumb scratch. An additional scratch coat that has been applied to obtain a uniform setting bed on a plumb vertical plane.

Pointing mix. A mortar mix with a consistency of stiff paste. The mix is forcibly compressed into the tile joints where it hardens.

Pointing trowel. Probably the most essential tool in the trade. This trowel comes in sizes ranging from 4 to 7 inches (10.2 to 17.8 centimetres) in length, but the 6-inch (15.2-centimetre) trowel is the most popular. The tilesetter uses this trowel in every phase of the work, especially for straightening tiles on walls and floors, marking floated surfaces, filling small depressions on float coats, buttering tiles and trim work, and placing mortar in areas that are too small for the flat trowel. The butt of the handle is used for tapping in tiles that are not on a true plane with the rest of the tilework. The trowel's flat working surface must be protected. The tilesetter should not use it to pry or chip hardened materials, such as concrete or plaster.

Polychrome decoration. A multicolor decoration. (ASTM C 242-72)

Porcelain. A glazed or unglazed vitreous ceramic whiteware used for technical purposes. This term designates such products as electrical, chemical, mechanical, structural, and thermal wares when they are vitreous. (See *Alumina porcelain, Cordierite porcelain, Forsterite porcelain, Steatite porcelain, Titania porcelain,* and *Zircon porcelain.)* (ASTM C 242-72)

Porcelain process. The method of producing glazed ware by which a ceramic body and glaze are matured together in the same firing operation. (ASTM C 242-72)

Porcelain tile. A ceramic mosaic tile or paver that is generally made by the dust-pressed method. The tile is dense, fine-grained, and smooth, with a sharply formed face that is usually impervious. Colors of the porcelain type are usually of a clear, luminous type or granular blend thereof. (ASTM C 242-72)

Porosity, apparent. The relationship of the open pore space to the bulk volume, expressed in percent. (ASTM C 242-72)

Pot life. The period of time during which a material maintains its workable properties after it has been mixed.

Pottery. All fired ceramic wares that contain clay when formed, except technical, structural, and refractory products. (ASTM C 242-72)

Prefloat. The term used to describe mortar that has been placed and allowed to harden prior to bonding tile to it with thin-set materials.

Pregrouted tile. A surface unit consisting of an assembly of ceramic tiles bonded together at the edges by a material, generally elastomeric, which seals the joints completely. Such material (grout) may fill the joint completely or partially and may cover all or part of the back surfaces of the tiles in the sheets. The perimeter of these factory pregrouted sheets may include all or part of the joint between the sheets or none at all. The term *edge-bonded tile* is sometimes used to designate a particular type of pregrouted tile sheets having the front and back surfaces completely exposed.

Pressing, dry. Forming ceramic ware in dies from powdered or granular material by direct pressure. (ASTM C 242-72)

Pressing, hot. A jiggering process wherein a heated profile tool or plunger is employed. (ASTM C 242-72)

Pressing, wet (Plastic pressing). Forming ceramic ware in dies from a plastic body by direct pressure. (ASTM C 242-72)

Primary clay (residual clay). A clay which remains geologically at its site of formation. (ASTM C 242-72)

Process, dry (dry mix). The method of preparing a ceramic body wherein the constituents are blended dry. Liquid may be added as required for subsequent processing. (ASTM C 242-72)

Process, wet (slip process). The method of preparing a ceramic body wherein the constituents are blended in sufficient liquid to produce a fluid suspension for use as such or for subsequent processing. (ASTM C 242-72)

Pure. See *Neat cement.*

Pure coat. A thin coat of pure portland cement which is used to bond tile to mortar.

Quarry tile. Unglazed tile, usually 6 square inches (38.7 square centimetres) or more in surface area and ½ to 1¼ inches (1.3 to 3.2 centimetres) in thickness, made by the extrusion process from natural clay or shales. (ASTM C 242-72)

Rack. A metal grid that is used to space and align floor tiles.

Rake or rake line. The inclination from a horizontal direction.

Raw glaze. A glaze compounded primarily from raw constituents. It contains no prefused materials. (ASTM C 242-72)

Receptor. A metallic or nonmetallic waterproof support for a shower stall. (TCA)

Reducer. A trim unit used to reduce the radius of a bullnose or a cove to another radius or to a square. (TCA)

Return. The ending of a small splash wall or a wainscot at a right angle to the major wall.

Rockingham ware. A semivitreous ware or earthenware having a brown or mottled brown bright glaze. Originated in England on the estate of the Marquis of Rockingham. (ASTM C 242-72)

Rodding. See *Floating.*

Rod saw. One of the newest tools used in the cutting of tile. It is a steel rod approximately $\frac{1}{8}$ inch (0.3 centimetre) in diameter. The rod has tungsten carbide particles embedded in the surface. The rod saw is used to cut circles or irregular curves in tile.

Roughing in. The act of preparing a surface by applying tar paper and metal lath (or wire mesh). Sometimes called wiring.

Rubber spacers. Cross and tee-shaped objects used to space tile on floors or walls. They are manufactured in thicknesses of $\frac{1}{16}$, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ inch (0.2, 0.3, 0.6, 1.0, and 1.3 centimetres).

Rubber trowel. A nonporous synthetic-rubber-faced float that is mounted on an aluminum back with a wood handle. This trowel is used to force grout deep into tile joints and to remove excess material for a perfect finish.

Rubbing stone. A Carborundum stone that is used to smooth the rough edges of tile.

Sag. A term used when a wall surface has developed a slide.

Salt glaze. A glaze produced by the reaction, at elevated temperature, between the ceramic body surface and salt fumes produced in the kiln atmosphere. (ASTM C 242-72)

Sampling. The method of obtaining tiles for testing from an agreed-upon lot.

Sandblasting. A method of scarifying the surface of concrete or masonry to provide a bondable surface. Compressed air is used to propel a stream of wet or dry sand onto the surface.

Scarifier. A piece of thin sheet metal with teeth or serrations cut in the edge. It is used to roughen fresh mortar surfaces to achieve a good bond for the tile. A scarifier also can be used to roughen the surface of concrete. (TCA)

Scratch. A mixture of portland cement, sand, and water.

Scratch coat. The first coat of mortar on a wall or ceiling. Its surface usually is scratched or roughened so it will bond correctly with subsequent coats of mortar. (TCA)

Scratched tiles. Tiles that have surface scratches caused by sand or tools during installation.

Scratcher. Any serrated or sharply tined object that is used to roughen the surface of one coat of mortar to provide a mechanical key for the next coat. See also *Scarifier.*

Scratching. The application of a scratch coat and its combing with a scratcher.

Screed. A strip of wood, metal, mortar, or other material applied to a surface. Screeds are used as guides on which a straightedge is worked to obtain a true mortar surface. (TCA)

Scribe. A tool used for working tiles for irregular cuts. It is made of steel and weighs approximately 1 ounce (28 grams).

Sculptured tile. Tile with a decorative design of high and low areas molded into the finished face. (CTI)

Sealant. An elastomeric material that is used to fill and seal the expansion joint. This material prevents the passage of moisture and allows horizontal and lateral movement at the expansion joint.

Secondary clay (sedimentary clay). A clay which has been geologically transported from its place of formation. (ASTM C 242-72)

Second-grade ceramic tile. Ceramic tile with appearance defects that do not affect wearing or sanitary qualities.

Self-spacing tile. Tile with lugs, spacers, or protuberances on the sides. These devices automatically space the tile for the grout joints. (SS-T-308b)

Semimat glaze. A colorless or colored glaze having moderate gloss. (ASTM C 242-72)

Semiporcelain. A trade term designating semivitreous dinnerware. (ASTM C 242-72)

Semivitreous (semivitrified). That degree of vitrification evidenced by a moderate or intermediate water absorption. (ASTM C 242-72)

NOTE: The term *semivitreous* generally signifies 0.5 to 10 percent water absorption, except for floor and wall tiles, which are considered semivitreous when water absorption is between 3 and 7 percent.

Setting bed. The layer of mortar on which the tile is set. The final coat of mortar on a wall or ceiling also may be called a setting bed. (TCA)

Shelf life. The period of time that an item can be stored before it is used.

Ship and galley tile. A special quarry tile having an indented pattern on the face of the tile to produce an antislip effect. (ASTM C 242-72)

Shivering (peeling). The splintering which occurs in fired glazes or other ceramic coating due to critical compressive stresses. (ASTM C 242-72)

Shower floor waterproof membrane. See *Waterproof membrane.*

Shower pan. Terminology used in some areas for *Waterproof membrane.* (CTI)

Shower receptor. The floor and side walls of the shower up to and including the curb of the shower. (CTI)

Shower receptor liner or lining. Terminology used in some areas for *Waterproof membrane.* (CTI)

Single fire. See *Fire, single.*

Sink angle. Trim shape used on a drainboard at the corners of the kitchen sink. This trim shape, which is AU 106, also is called a *butterfly.*

Sinter. A ceramic material or mixture fired to less than complete fusion, resulting in a coherent mass. (ASTM C 242-72)

Skim coat. See *Bond coat.*

Slide. A fresh tile wall that has buckled or sagged. This condition may be caused by excessive mortar, insufficient lime in the mortar, or excessive moisture in the scratch coat. A slide also may result if the surface is slick or the mortar is too soft.

Slip coating. A ceramic material or mixture other than a glaze, applied to a ceramic body and fired to the maturity required to develop specified characteristics. (ASTM C 242-72)

Slip glaze. A glaze consisting primarily of a readily fusible clay or silt. (ASTM C 242-72)

Slip process. See *Process, wet.*

Slip-resistant tile. Tile that has greater slip-resistant characteristics due to an abrasive admixture, abrasive particles in the surface, or grooves or patterns in the surface.

Slip (slurry). A suspension of ceramic material in liquid. (ASTM C 242-72)

Slot cut. Description of a tile that has been cut to fit around pipes or switch boxes. This tile is usually in the shape of the letter *H* or the letter *L*.

Slush coat. A pure coat of a very soft consistency. This also is called a *slurry coat.*

Soap, neutral. A soap recommended for cleaning tiled surfaces. It should be neither acidic nor alkaline.

Soaping tile. The method of applying a soapy film to newly tiled walls to protect them from paint and plaster during construction. (TCA)

Soldier course. Oblong tile laid with the long side vertical and all joints in alignment.

Solid casting. See *Casting, solid.*

Spacing mix. A dry or dampened mixture of one part portland cement and one part extra-fine sand. This mix is used as filler in the joints of mounted ceramic mosaic tiles to keep them evenly spaced during installation.

Special-purpose tile. A tile, either glazed or unglazed, made to have specific physical design or appearance characteristics, such as size, thickness, shape, color, or decoration; keys or lugs on backs or sides; and special resistance to staining, frost, alkalies, acids, thermal shock, physical impact, high coefficient of friction, or electrical properties. (ASTM C 242-72)

Spitout. A glaze defect of the pinhole type developed in the decorating kiln, due to evolution of minute gas bubbles from the body or glaze. (ASTM C 242-72)

Splash walls. The walls of a tile drainboard or bathtub.

Split L cut. An improper L cut that is made by splitting a tile instead of cutting it.

Spots. Small pieces of tile placed on a wall or floor surface to align the screeds or setting bed. Spots of casting plaster also may be used.

Stacking tile. A method of installation whereby glazed tiles are placed on the wall so that they are in direct contact with the adjacent tiles. The width of the joints is not maintained by the use of string or other means. The tiles may be set with either straight or broken joints. (TCA)

Standard-grade ceramic tile. Highest grade of all types of ceramic tile.

Steatite porcelain. A vitreous ceramic whiteware for technical application in which magnesium metasilicate ($\mathrm{MgO\ SiO_2}$) is the essential crystalline phase. (ASTM C 242-72)

Steatite talc. Massive talc or the pulverized product thereof having the general formula $\mathrm{3\ MgO \cdot 4SiO_2 \cdot H_2O}$. (ASTM C 242-72)

Steatite whiteware. Any ceramic whiteware in which magnesium metasilicate ($\mathrm{2MgO \cdot SiO_2}$) is the essential crystalline phase. (ASTM C 242-72)

Steel square. One of the most important tilesetting tools. The large arm of the square is 2 inches (5.1 centimetres) wide and 24 inches (61 centimetres) long and is called the body or blade. The smaller arm is at a 90-degree angle to the blade and is 1½ inches (3.8 centimetres) wide and 16 inches (40.6 centimetres) long; it is called the tongue. The point where the outside edges of the blade and tongue join is called the heel. The surface with the manufacturer's name is called the face; the opposite surface is called the back.

Stoned. Use of a Carborundum stone to eliminate the jagged and flaked edges, which result from cutting.

Stoneware. A vitreous or semivitreous ceramic ware of fine texture, made primarily from nonrefractory fire clay. (ASTM C 242-72)

Story pole. See *Layout stick.*

Straightedge. A straight piece of lumber that is used to rod mortar and to align tile.

Straight joint. The usual style of laying tile where all the joints are in alignment.

Stretcher. Trim shapes of tile between trim angles.

Striking joints. A process of removing excessive grout from the joints by wiping with a sponge or cloth or scraping with a curved instrument. (TCA)

Structural defects. Cracks or laminations in the body of the tile which detract from the aesthetic appearances and/or the structural soundness of the tile installation.

Substrate. The underlying support for the ceramic tile installation.

Take-off person. Someone who can read blueprints and is familiar with the specifications. This person makes tracings of special details concerning the tilework after gathering the necessary information and then estimates the labor, materials, tile quantities, and special trim shapes needed to complete the job.

Tapping tile. An inspection technique whereby a coin, key, or other small metallic object is tapped against an installed tile to determine by sound whether the tile is completely bonded to its backing. Tilesetters often tap the tile with a pointing trowel to determine that a good bond has been achieved. (TCA)

Terra cotta. Hard baked clayware, including tile, of variable color, averaging reddish red-yellow in hue and of high saturation. (CTI)

Terra sigillata. A porous, red clayware characterized by embossed decorations of the same color and a satin-like unglazed surface. Originated on the Island of Samos. (ASTM C 242-72)

Terrazzo tile. A terrazzo surface, on a portland cement and sand body, made by a mixture of marble chips and portland cement and usually ground smooth. (CTI)

Tessera, tesserae. A small chip of glass or marble used in mosaic formations. (CTI)

Testing of ceramic tile. The act of determining whether ceramic tiles are acceptable. See *Physical properties of ceramic tile.*

Thin-set. A term used to describe the bonding of the tile with suitable materials applied approximately ⅛ inch (0.3 centimetre) thick. See also *Dry-Set mortar.*

Tie wire. The 18-gauge galvanized wire used in construction work.

Tile. A ceramic surfacing unit, usually relatively thin in relation to facial area and made from clay or a mixture of clay and other ceramic materials. The body of the tile has either a glazed or unglazed face and is fired above red heat in the course of manufacture to a temperature sufficiently high to produce specific physical properties and characteristics. (ASTM C 242-72)

Tile assemblies. See *Mounted tile.*

Tile cutter. One of the most efficient and economical tools in the tilesetting trade. A popular model is the hand-drawn tile cutting board that is adjustable.

Tile, mounted. Tiles assembled into units or sheets and bonded together to facilitate handling. (TCA)

Back-mounted tile. Mounted tile with perforated paper, fiber mesh, or other suitable bonding material applied to the backs or edges of the tile so that a relatively large proportion of tile area is exposed to the setting bed.

Face-mounted tile. Mounted tile with paper applied to the faces of the tile. The water-soluble adhesive can be removed easily prior to grouting of the joints.

Titania porcelain. A vitreous ceramic whiteware for technical application in which titania (TiO_2) is the essential crystalline phase. (ASTM C 242-72)

Titania whiteware. Any ceramic whiteware in which titania (TiO_2) is the essential crystalline phase. (ASTM C 242-72)

Trammel bar. An easily constructed but accurate layout tool. It is used to erect perpendicular lines and to bisect angles. The tilesetter can make a trammel bar from a stick of a size that is suitable for the particular job.

Trimmers. Units of various shapes consisting of such items as bases, caps, corners, moldings, and angles. These units are used to complete an installation. (ASTM C 242-72)

Underglaze decoration. See *Decoration, underglaze.*

Unglazed paver tile. See *Paver tile.*

Unglazed quarry tile. See *Quarry tile.*

Unglazed tile. A hard, dense tile of homogeneous composition throughout, deriving color and texture from the materials that make up the body. The colors and characteristics of the tile are determined by the materials used in the body, the method of manufacture, and the thermal treatment. (ASTM C 242-72)

Vellum glaze. A semimat glaze with a satin-like appearance. (ASTM C 242-72)

Vertical broken joint. Style of laying tile with each vertical row of tile offset for half its length.

Vitreous slip. A slip coating matured on a ceramic body, producing a vitrified surface. (ASTM C 242-72)

Vitreous (vitrified). That degree of vitrification evidenced by low water absorption. (See also *Impervious; Nonvitreous;* and *Semivitreous.*) (ASTM C 242-72)

NOTE: The term *vitreous* generally signifies less than 0.5 percent absorption, except for floor and wall tiles and low-voltage electrical porcelains, which are considered vitreous up to 3 percent water absorption.

Vitrification. The progressive reduction in porosity of a ceramic composition as a result of heat treatment. (ASTM C 242-72)

Vitrification range. The maturing range of a vitreous body. (ASTM C 242-72)

Wall tile. A glazed tile with a body that is suitable for interior use and that is usually nonvitreous. The tile is not expected to withstand excessive impact nor be subjected to freezing and thawing conditions.

Water level. A piece of clear plastic hose ⅜ to ½ inch (1.0 to 1.3 centimetres) in diameter and usually about 50 feet (15 metres) in length. It is filled with water, from which all air must be removed. Air bubbles in the hose compress when the level is used.

Waterproof membrane. A membrane, usually made of built-up roofing, to provide a positive waterproof floor over the substrate, which is to receive a tile installation using a wire-reinforced mortar bed. (CTI)

Wet areas. Interior or exterior tiled areas subject to periodic or constant wetting. Examples: showers, sunken tubs, pools, exterior walls, roofs, exterior paving, and interior floors. (CTI)

Wet pressing. See *Pressing, wet.*

Wet process. See *Process, wet.*

Whiting. Calcium carbonate powder of high purity. (ASTM C 242-72)

Wood float. A tool that can be used in place of the flat trowel for floating mortar. It is good for smoothing small irregularities left on the mortar bed, working the surface of the mortar before troweling on the pure coat, or compacting floor and deck mortar.

Wrinkled sheets. Pertaining to ceramic mosaics mounted on paper. This condition results from rough handling in shipment.

Yellow ware. A yellow semivitreous ware or an earthenware with a colorless clear glaze. (ASTM C 242-72)

Zircon porcelain. A vitreous ceramic whiteware for technical application in which zircon ($ZrO_2 \cdot SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Zircon whiteware. Any ceramic whiteware in which zircon ($ZrO_2 \cdot SiO_2$) is the essential crystalline phase. (ASTM C 242-72)

Instructional Materials

Books for Each Apprentice

American National Standard Specifications Book (Latest edition). Contains all installation and material specifications and standards. New York: Tile Council of America, Inc. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. $3.)

American National Standard Specifications for Ceramic Tile (ANSI A137.1-1980). (Latest edition). New York: Tile Council of America, Inc. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. $3.00.)

Hobbs, Glen M., and James McKinney. *Practical Mathematics* (Third edition). Chicago: American Technical Society, 1973. (Orders to American Technical Publishers, Inc., 12235 South Laramie Ave., Alsip, IL 60658. Separate chapter pamphlets of the second edition of *Practical Mathematics* also are available from the publisher.)

Introduction to Apprenticeship (Workbook and Testbook). Sacramento: California State Department of Education, Revised 1973. (Orders to California State Department of Education, P.O. Box 271, Sacramento, CA 95802. Price available on request.)

Sundberg, E. W. *Building Trades Blueprint Reading—Part I, Fundamentals* (Fifth edition, revised). Chicago: American Technical Society, 1972. (Orders to American Technical Publishers, Inc., 12235 South Laramie Ave., Alsip, IL 60658.

Tilesetting (Workbook and Testbook). Sacramento: California State Department of Education, 1981. (Orders to California State Department of Education, P.O. Box 271, Sacramento, CA 95802. Price available on request.)

Books for the Classroom Library

American National Standard ANSI A10-20-1977 (Latest edition). Safety requirements for ceramic tile, terrazzo, and marble work. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. $4.50.)

Construction Safety Orders (Latest edition). San Francisco: California State Department of Industrial Relations, Division of Industrial Safety. (Orders to Department of General Services, Publications Section, P.O. Box 20191, Sacramento, CA 95820. $1.25.)

Handbook for Ceramic Tile Installation (Latest edition). Tile Council of America, Inc. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. $1.)

Standard Specification for Installation of Ceramic Tile with Water Resistant Organic Adhesives (CTI-R4-101-62) (Latest edition) Los Angeles: Ceramic Tile Institute. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. No charge.)

Standard Specifications for the Installation of Tile-Lined Shower Receptors (CTI-R8-103-62) (Latest edition). Los Angeles: Ceramic Tile Institute. (Orders to Ceramic Tile Institute, 700 North Virgil Ave., Los Angeles, CA 90029. No charge.)

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